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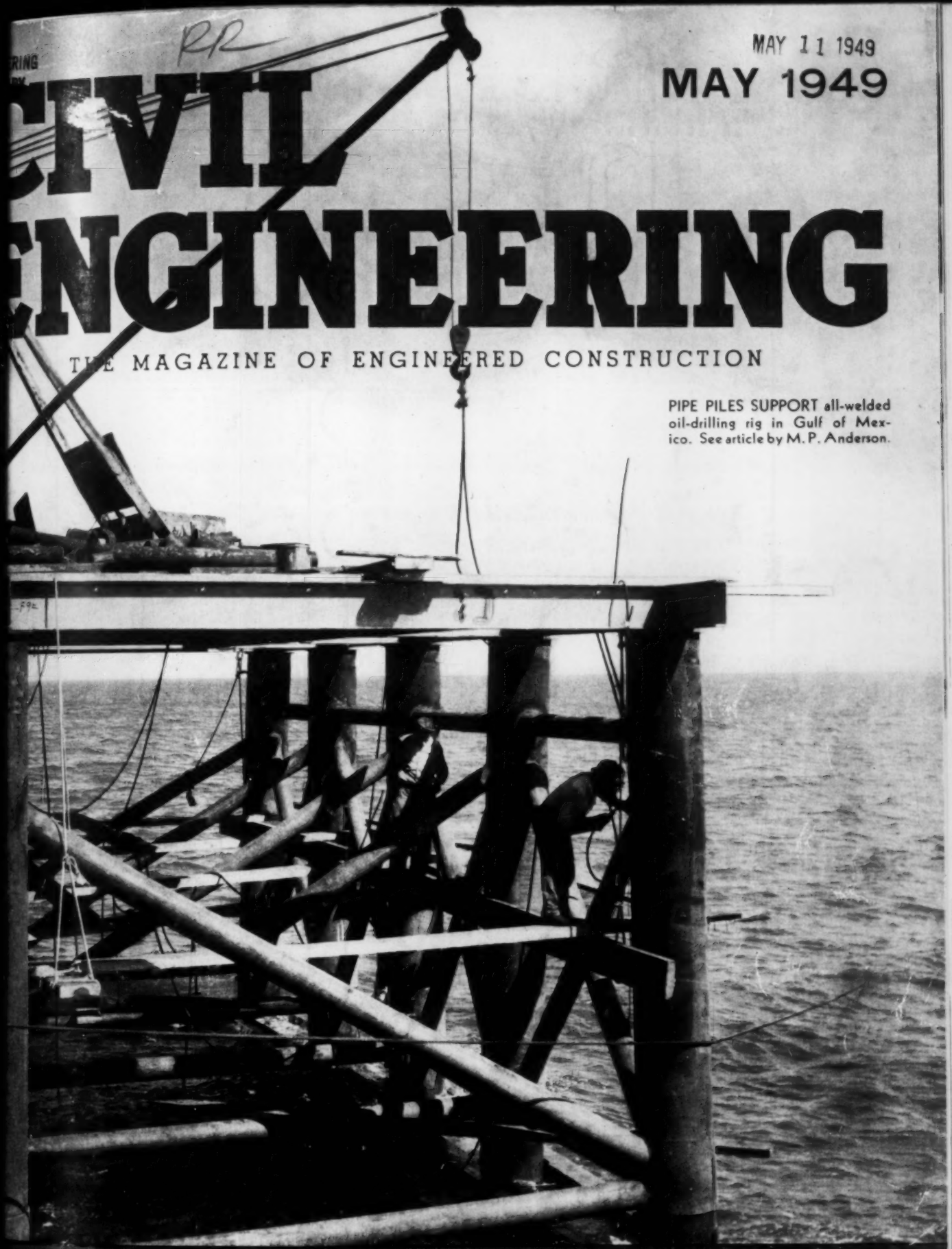
CIVIL ENGINEERING

THE MAGAZINE OF ENGINEERED CONSTRUCTION



PIPE PILES SUPPORT all-welded oil-drilling rig in Gulf of Mexico. See article by M. P. Anderson.

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New Plant Treats Oklahoma City Sewage for Reuse

Tee Cools Mix for Fort Gibson Dam—Chorpening

Oklahoma City Spring Meeting Papers Reviewed

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CIVIL ENGINEERING

THE MAGAZINE OF ENGINEERED CONSTRUCTION

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"Our FORD F-8 pulled a 25-ton shovel up 4th St. Hill!"

Roadside Report

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W. A. WADSWORTH

DAYTON, OHIO

"RECENTLY we had occasion to place our 25-ton shovel at the top of East 4th Street Hill in Dayton," reports W. A. Wadsworth, General Manager of Southern Hills Pit, Inc. "We did this with our Ford F-8 Big Job without the assistance of a second truck and had a comfortable reserve of power. To our knowledge, no other make of truck has pulled the hill our F-8 did, with a similar load."

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ONLY THE FORD BIG JOB HAS ALL THESE FEATURES!

- ★ New 145-h.p. Ford V-8 engine for top performance.
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USING REGISTRATION DATA ON 5,444,000 TRUCKS, LIFE INSURANCE EXPERTS PROVE FORD TRUCKS LAST LONGER!

Oklahoma City Builds

Two-Stage Trickling-Filter Sewage Disposal Plant

WEBSTER L. BENHAM, Director, ASCE
Benham Engineering Co., Oklahoma City, Okla.

WASTES FROM SLAUGHTER HOUSES, packing houses and oil fields within Oklahoma City aggravate the already difficult sewage treatment and disposal problem of the municipality. When the new two-stage trickling-filter South Side Plant, designed to serve these industries and 175,000 of the 300,000 population of the city and environs, is completed effluent can be discharged safely and inoffensively into the North Canadian River, which is dry most of the year. Designed to maintain self-cleansing velocities, the main outfall reaches the site of the South Side Plant 18 ft below grade, requiring a 24-ft pump lift. The high groundwater level, which is 3 ft below the surface, has complicated the structural design and retarded construction. The pump house is weighted, and tanks are provided with groundwater-pressure relief valves to prevent flotation. The contractor is using a system of well points to control groundwater levels during construction. Walls and domes of the 90-ft-dia digester tanks are prestressed concrete with reinforcing prestressed to 140,000 psi. In the address on which this article is based, Mr. Benham told the Sanitary Engineering Division that he expects this unusual four-million-dollar plant to be in operation by January of 1950.

OKLAHOMA CITY has no year-round flowing streams into which effluent from its sewage disposal plants can be discharged. It's two existing treatment plants afford little more than primary treatment, using ferric chloride and lime for partial removal of suspended solids and reduction of B.O.D. Considerable sums in judgments for damages due to inadequate treatment of sewage and pollution have been paid in past years and many suits are pending.

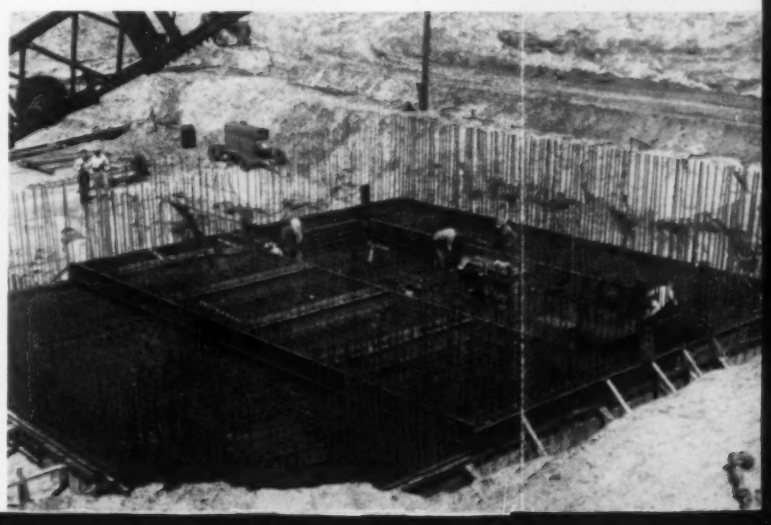
Consequently two new plants have been designed, each to produce an effluent low in B.O.D. and containing nitrites and nitrates so that it will sustain itself without dilution. Oklahoma City's population is 275,000, or 300,000 including environs. Two-thirds of the urban area drains naturally into the North Canadian River, one third into the Deep Fork River. The present South Side Treatment Plant cost $775,000, and the North Side Treatment Plant, $230,000. Proceeds of the bond issue voted in 1945 in the amount of $9 million are building new main and sub-main sewers, and a two-stage trickling-filter plant to treat 25 mgd, which is under construction to replace the old South Side Plant. An activated sludge plant for 10 mgd has been designed to replace the present North Side plant but on account of rising construction costs, this plant cannot be built until additional bonds are voted. This article gives reasons for selecting the type designed for the South Side Plant, the larger of the two; a description of the elements of the plant and their sanitary functions; and the costs.

Packing-house and slaughter-house wastes add to the potency of the sewage to be treated. At times large quantities of oil and oil wastes from oil fields within the city limits get into the collecting sewers and must be removed with skimmers before the sewage reaches the filters to prevent serious interference with the treatment processes.

Suitable Types of Treatment Studied

Studies of the most suitable types of treatment to be used were made on (1) two-stage high-rate–low-rate trickling filters, (2) two-stage biofiltration, and (3) activated sludge. Two-stage biofiltration will produce an effluent low in B.O.D. but lacking in nitrites and nitrates and therefore this method would not produce a suitable effluent for discharge into the North Canadian River, which has little or no flow the greater part of the time. As for the activated sludge process, it is well known that when a plant of this type is operating nor-

CONSTRUCTION OF MAIN PUMP STATION for Oklahoma City's South Side Sewage Treatment Plant requires use of well points to dewater foundation. Reinforcing steel for floor of raw sewage wet well and pump room is being placed in view below, left, and formwork is being started in view at right. Well points are installed along benches at levels above floor.



mally it will produce an effluent which entirely meets the requirements of the receiving stream. However, when the sewage contains industrial wastes the process tends to be "temperamental" and over an extended period of time the effluent might not be as good as that from a trickling filter plant. For these reasons the two-stage high-rate–low-rate trickling-filter type of treatment was adopted as best suited to produce the required effluent.

The South Side Plant, shown in Fig. 1, is designed to treat 25 mgd of combined domestic sewage and packing-house wastes (from the Armour and Wilson packing houses and eleven small slaughter houses) having a B.O.D. of 375 ppm, and 500 ppm of suspended solids. The packing-house plants are being required to remove grease, hair and paunch manure from their wastes before discharge into the sewers. The contributory population is 175,000 and the present flow 18 to 20 mgd, but the plant is designed for an equivalent population of 460,000 and is laid out to permit 50 percent expansion without replacing any of the present construction.

Production of Nitrites and Nitrates

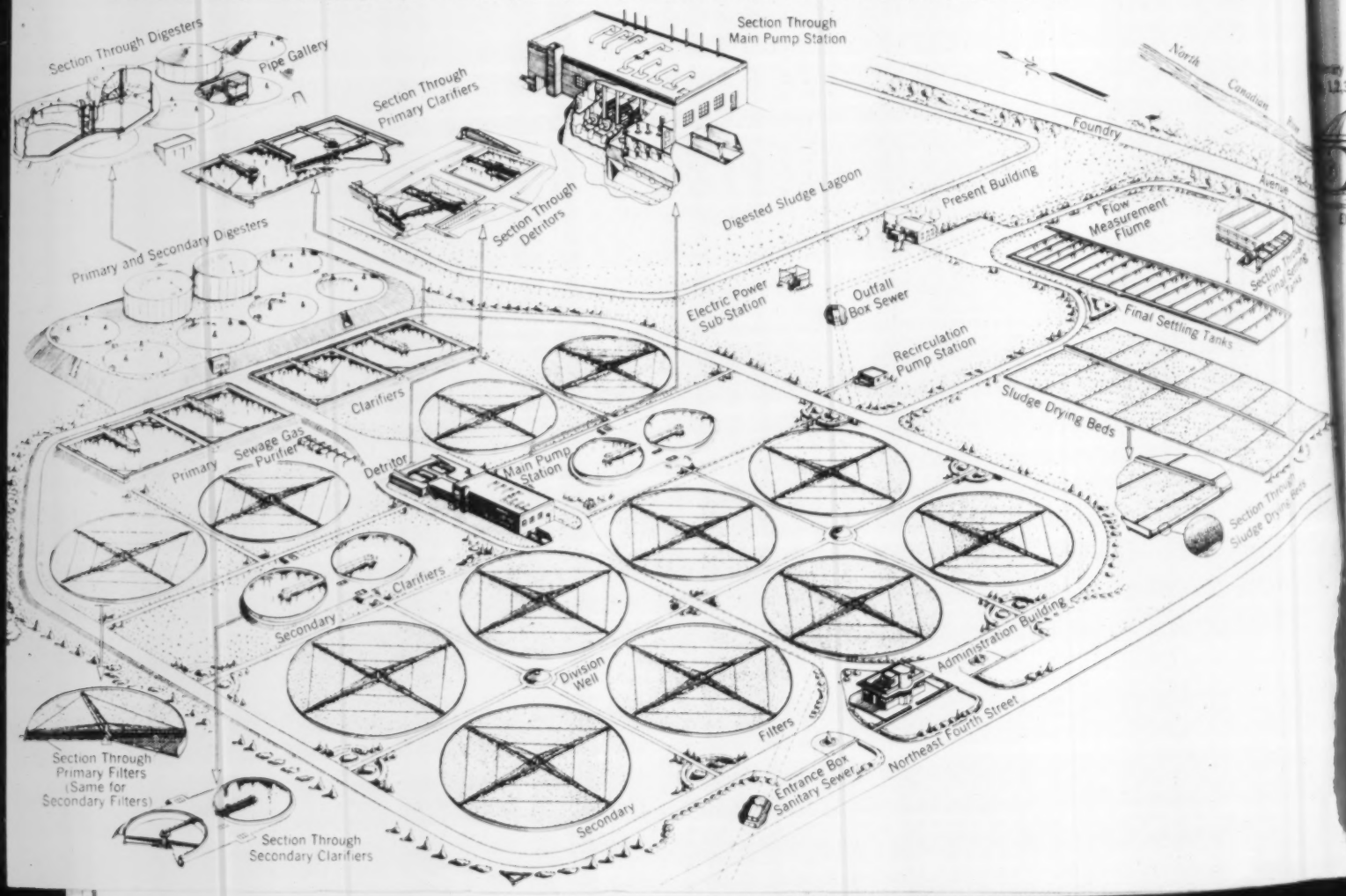
The first stage of filtration is high-rate biofiltration to remove as much B.O.D. as possible, and the second stage is low-rate filtration without recirculation to produce an effluent low in B.O.D. and containing nitrites and nitrates so that it may be discharged into a nearly dry stream without creating a nuisance. The main sewer, designed to maintain self-cleansing velocities, arrives at the plant site 18 ft below grade. Sewage is lifted 35 ft at the plant with centrifugal pumps driven by digester-gas engines. The twelve trickling filters are among the largest ever built, and the plant itself covers 35 acres, exclusive of the sludge lagoon. The present minimum flow was used in designing the size of the channels and pipelines to assure velocities of not less than 1 ft per sec except where the channel or pipe follows a settling tank. In establishing the elevations of settling tanks and filters, the peak flow was used.

A diagrammatic flow chart, Fig. 2, shows the flow and circulation of sewage, sludge and effluent. Downstream from the trash racks is located a floating oil-skimmer. The accumulated oil, grease and scum are drained into a sump with an airtight lid whence they are blown to the surface with compressed air to be burned. On the way to the raw-sewage wet well, the at least partially oil-free sewage passes through four Chicago Pump Co. comminutors arranged for dual or multiple operation, each with a capacity of 11 mgd, where rags and solids are cut.

Four Worthington raw-sewage pumps, each with a capacity of 20 mgd operating against a total head of 40 ft, are direct driven by 210-hp Worthington gas engines. No electric standby power is needed since natural gas is plentiful and low in cost in this section of the country. Engines will be started and stopped manually but the speed, and thus the pumping rate, is controlled by floats resting on the liquid in the wet well. Jacket water from the raw-sewage pump engines and from the recirculation pump engines will be used to heat the digesters.

Raw incoming sewage is pumped to a channel just under the roof of the pump building and 6 ft above grade. Each pump discharges separately through a gooseneck, the outlet of which is above the highest water level in the channel to eliminate the need of either check or gate valves in the discharge lines and to obtain the full capacity of each pump regardless of the number of pumps operating

FIG. 1. OKLAHOMA CITY'S NEW South Side Sewage Disposal Plant, now under construction, covers 35 acres. Because of flat terrain, sewage must be lifted 24 ft at plant. Groundwater level at site, 3 ft below surface, demands special attention to structural design. Twelve trickling filters, among largest built, require 1,750 carloads of two-cycle crushed stone for filter material.



at any one time. The pump suctions, of course, are to be valved. Installed in this channel at the north end of the building is a Parshall flume for metering the raw sewage flow. At the upstream end of the channel is a by-pass leading to the main by-pass and outfall of the plant so that at high river stage, when raw sewage connot be by-passed directly from the incoming sewer, it can be pumped and then by-passed. At normal river stage it can be by-passed directly.

The sewage flows in the raw sewage channel to the two Dorr detritors, each 22 ft square. The settled organic matter is washed from the grit and returned to the sewage flow. The washed grit will be used for fill on the plant grounds.

Directly downstream from the detritors, the recirculation from the primary filters joins the raw sewage flow and the mixture flows to the primary clarifiers through a 78-in. sewage line having a velocity of over 1 ft per sec at the present minimum flow.

The four square primary Dorr clarifiers of the center-feed type have a detention period of approximately two hours at design flow plus a recirculation flow equal to the design flow—or a total of 50 mgd and an overflow rate of about 1,000 gal per sq ft per day. These clarifying tanks will remove about one-third of the organic load. Clarifiers are equipped with circular scum skimmers which operate inside a circular baffle plate. The sludge from the clarifiers is drawn off into sludge wells by hydrostatic pressure and the scum drains to these same wells. The sludge flows from the wells through steeply sloped lines to the raw-sludge suction well and is pumped from there to the digesters.

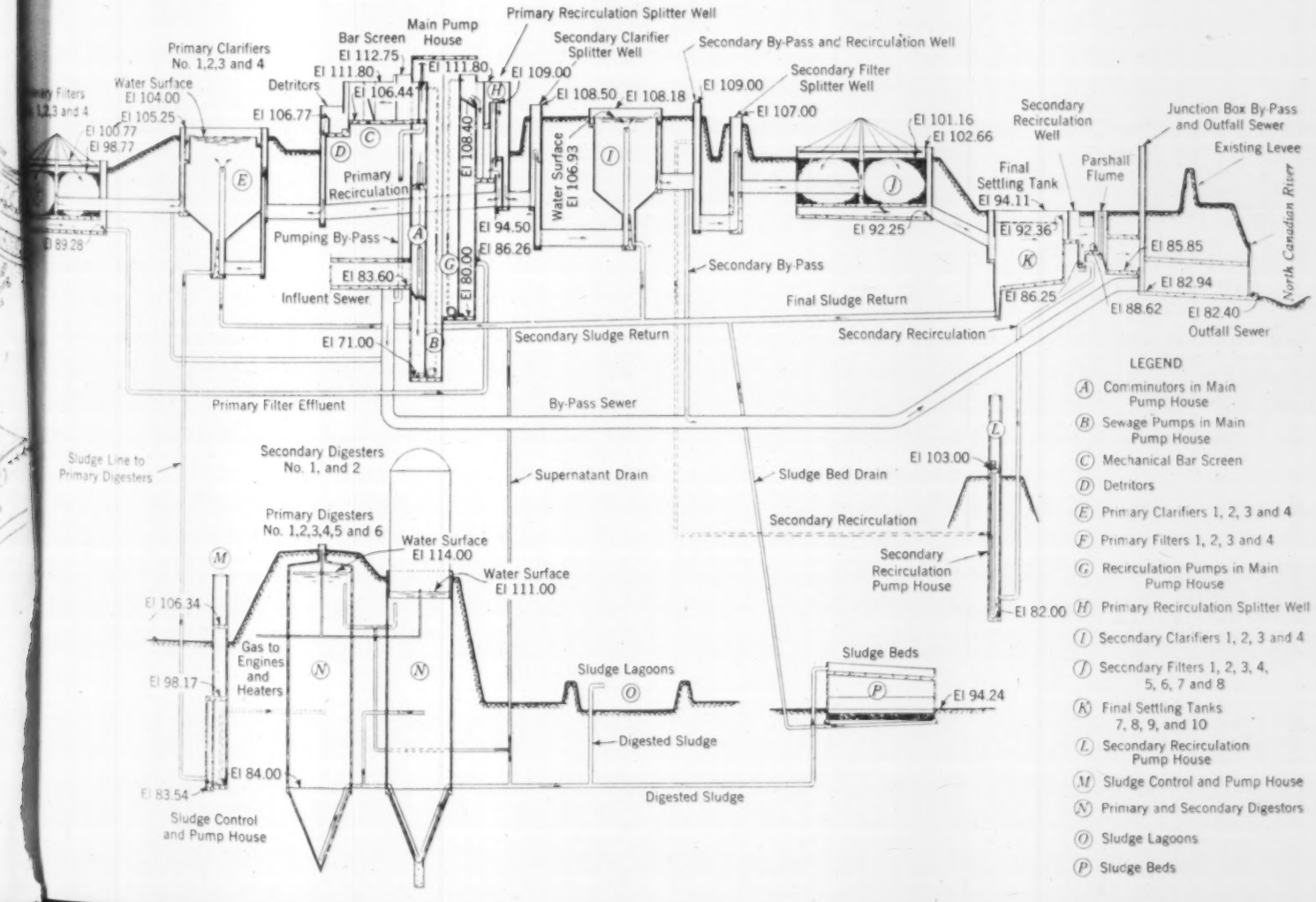
Trickling Filters Among Largest Built

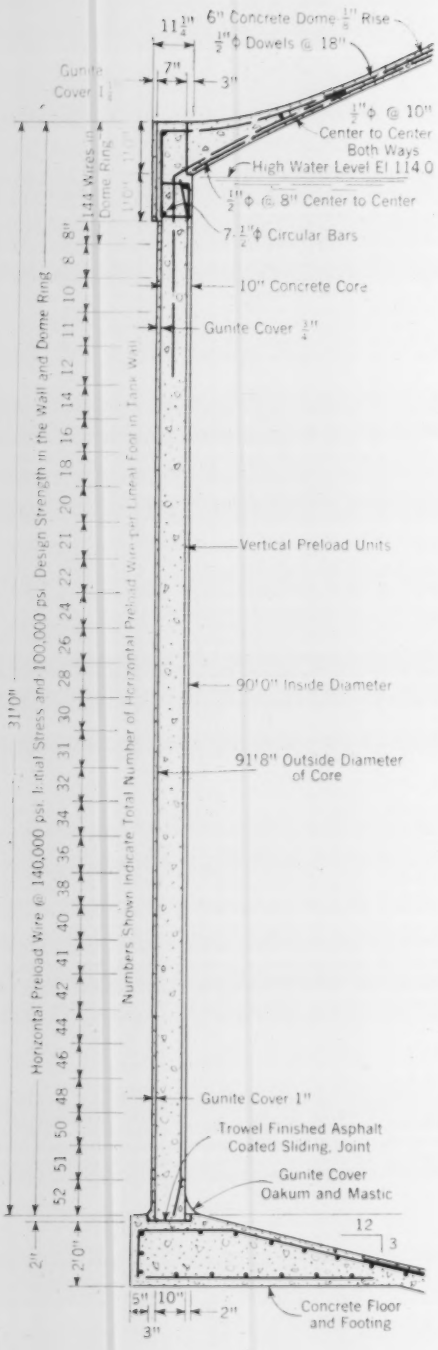
Settled sewage from the primary clarifiers flows to the four primary high-rate filters which are 166 ft in diameter and will contain a 6-ft depth of rock with a total area of two acres. The settled sewage is distributed over 20-cycle rock $2^1/_2$ to $3^1/_2$ in. in size by Dorr Co. rotary distributors at a dosing rate of 25 mgd per acre. The loading of B.O.D. will be 4,330 lb per acre-ft per day, at which rate it is expected that the effluent from the following intermediate clarifiers will contain approximately 60 ppm of B.O.D.

The primary filter effluent flows to the recirculation wet well, which will be in the same building with the raw-sewage wet well and adjoining it. This wet well is set 9 ft higher than the raw sewage wet well. Three Worthington recirculation pumps each with a capacity of 20 mgd, operating against a total head of 30 ft, are driven by 175-hp Worthington gas engines. One of the raw sewage pumps is connected to both wet wells and will be used as a swing pump. Each pump discharges through a separate gooseneck into a channel which leads to a recirculation splitter well just outside the building, where the flow is divided into three parts—the primary recirculation and the flows to the two pairs of intermediate clarifiers. The primary recirculation is taken out through an adjustable-size submerged orifice through which the flow will be constant within 5 percent, regardless of the flow variation during the day. The primary filter effluent to the intermediate clarifiers flows over a weir around three sides of the well into a channel. A stop gate divides the overflow of the weir to suit the number of secondary filters in use. A differential water-level recorder will enable a reasonably close determination of the recirculation flow.

The primary-filter effluent flowing over the weir of the splitter well,

FIG. 2. DIAGRAMMATIC FLOW CHART indicates flow of sewage and sludge to various units of plant. When flow in river is large, secondary treatment can be omitted.




6" Concrete Dome 1" Rise
1/2"φ Dowels @ 18"
7"
3"
Gunite Cover 1 1/4"
1/2"φ @ 10" Center to Center Both Ways
High Water Level El 114.0
1/2"φ @ 8" Center to Center
7-1 1/2"φ Circular Bars
10" Concrete Core
Gunite Cover 3/4"
144 Wires in Dome Ring
Vertical Preload Units
90'0" Inside Diameter
91'8" Outside Diameter of Core
Horizontal Preload Wire @ 140,000 psi Initial Stress and 100,000 psi Design Strength in the Wall and Dome Ring
Numbers Shown Indicate Total Number of Horizontal Preload Wire per Lineal Foot in Tank Wall
31'0"
Gunite Cover 1"
Trowel Finished Asphalt Coated Sliding Joint
Gunite Cover Oakum and Mastic
12
3
2'0"
2"
5"
10"
2"
3"
Concrete Floor and Footing

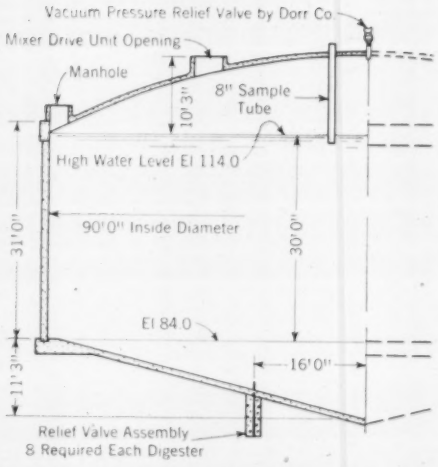


FIG. 3. PRIMARY DIGESTER TANKS (six) 90 ft in diameter (shown above) have 10-in. walls 30 ft high, reinforced with wire preloaded to 140,000 psi (at left) and fixed concrete domes 6-in thick supported on prestressed ring. There are also two secondary digesters of similar design and dimensions, except for domes, which are equipped with Dorr floating gas-holders.

equal in quantity to the sewage flow at the time, flows to the four Dorr intermediate clarifiers, of the round center-feed type, which will have a detention period of approximately 1 3/4 hours and an overflow rate of about 1,000 gal per sq ft per day. Sludge is removed by hydrostatic pressure as in the primary clarifiers, but continuously and at a higher rate. The sludge flows by gravity to the raw-sewage wet well to mix with the raw sewage and be settled out in the primary clarifiers as part of the raw sludge.

Effluent from these intermediate clarifiers, having received complete single-stage treatment, can be sent ahead for second-stage treatment at normal river stage or by-passed to the receiving stream at times of high river stage. At normal river stage the effluent from the intermediate clarifiers flows to two groups of four secondary filters, eight altogether, each 186 ft in diameter, with a total area of 5 acres and with a 6-ft rock depth. The secondary effluent is distributed over the 20-cycle rock (1 1/2 to 2 1/2 in. size) by Dorr Co. rotary distributors at a dosing rate of not over 5 mgd per acre. A B.O.D. loading of 416 lb per acre-ft per day was used as the design factor. A small amount of recirculation is provided to be used at night to keep the distributors operating and the rock wet at minimum flow. Use of this low rate of recirculation should not affect the quantity of nitrites and nitrates produced.

Existing Settling Tanks Utilized

The now twice-filtered sewage flows through a box sewer to the final settling tanks, which are a part of the present South Side Plant. There are four of these rectangular tanks divided into 16 flow-through channels using conveyor-type sludge collecting equipment. The collecting equipment will be renovated with all new chain, sprockets, return rails, and wearing shoes. The inlet and outlet channels will be rebuilt and U-shaped weirs added to give a weir rate of 15,625 gal per day per ft of weir length. The detention period in these tanks at the design rate is two hours and the overflow rate if 725 gal per sq ft per day. Sludge will be drawn as in the intermediate clarifiers and will flow by gravity to the raw-sewage wet well.

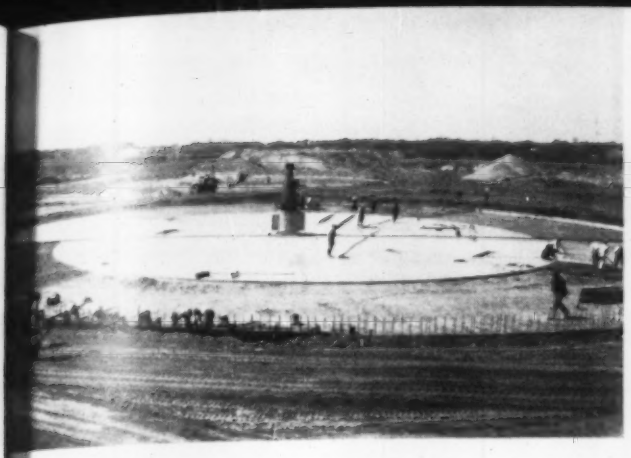
The effluent, metered through a Parshall flume, is discharged into the North Canadian River. Final effluent will be used for secondary recirculation, watering lawns, flushing sludge lines and washing down tanks, and as a coolant when the digesters need less heat than is recovered from the gas engines by the jacket water. It will flow by gravity to a secondary recirculation wet-well, whence it will be pumped for the above-mentioned uses.

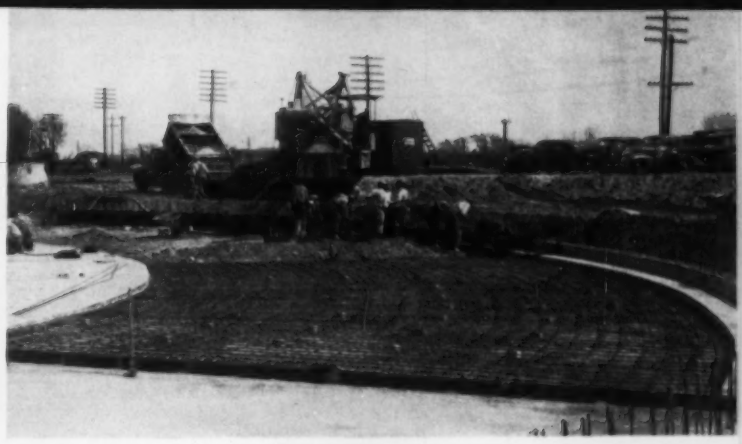
Digester Gas Operates Pumping Engines

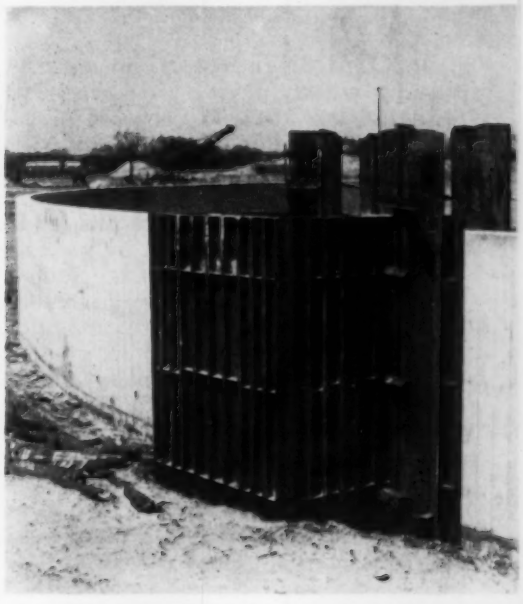
Eight Dorr digesters with a total capacity of 1,600,000 cu ft—3.6 cu ft per capita on an equivalent basis and 7.5 cu ft per capita on the present actual population—provide ample space for digestion. These 90-ft-dia tanks are laid out in two rows of four each with an operating gallery running the full length between the rows. Six of the eight tanks are primary digesters with fixed-dome roofs and the remaining two are secondaries equipped with Dorr gas holders each having a gas storage capacity of approximately 100,000 cu ft and ballasted to give 10 in. of water pressure. The system can be operated as two-, three-, or four-stage digestion.

Structurally the digester walls (Fig. 3) are 10 in. thick, reinforced with steel prestressed to 140,000 psi. Concrete contains Pozzolith admixture for workability and watertightness. Fixed prestressed domes on the primary digesters are 6 in. thick, supported on prestressed ring collars. Oakum and master joints under a cove at the juncture of the wall and floor prevent leakage. Eight special pressure-relief valves in the floor of each digester provide protection against accidental flotation. The digesters and final settling tanks are not designed for groundwater uplift. It will be necessary to lower the groundwater level by pumping from gravel-walled wells, which have been provided, before emptying these structures.

Digesters are maintained at optimum temperature by passing jacket-water from the gas engines through three spiral heat exchangers, one for each pair of primary digesters. When this method is insufficient to heat the digesters, the jacket-water will be passed through exhaust waste-heat boilers. When necessary, a part of the jacket water will be passed through gas-fired boilers located in







FLOOR AND FOOTING for 186-ft-dia secondary filter for Oklahoma City's South Side Sewage Treatment Plant are poured by Mulit-Foote paving mixer. General view of filter floor under construction appears at top, left. In view directly above, left, boom swings out to position concrete bucket over section being poured. In view at top, right, materials for batch are being delivered by truck, and concrete bucket has been drawn into position to receive new batch of concrete. Filter, one of eight in plant, will have 6-ft depth of rock. Inspection well and completed wall appear in view immediately above, right.

the main pump building. Sludge or supernatant liquor from the digesters will be pumped through the heat exchangers, to absorb the jacket-water heat, and back into the digesters. Digested sludge will be air dried on the sludge drying beds or in the lagoon of the present plant.

It is expected that 600,000 cu ft of gas per day will be produced. Before use, it will be passed through hydrogen sulfide removal units. The city water contains 100 ppm of SO_4 radical, and a concentration in the gas of H_2S too high for safe use in engines is expected. The removal unit consists of three boxes each 18½ ft in inside diameter with an iron-sponge depth of 3 ft. The boxes will all be interconnected so that they can be used in any combination desired.

Except for the sewage-gas-driven pumps, electricity will be used for power throughout the plant. The electricity is purchased by the city at a flat rate of 7 mills per kwhr. Gas produced would be sufficient to operate both the gas-engine-driven pumps and enough generators to produce all the power needed at the plant. However, it is doubtful whether the small power demand at the plant will justify the capital cost of generating equipment when outside power can be purchased at 7 mills.

The two-story, air-conditioned administration building, somewhat modernistic in design, is located at the front of the site on Northeast Fourth Street. It houses offices, laboratory, and a fireproof vault for storing records. The laboratory contains a room held at 20 deg F for all B.O.D. work, and equipment for chemical and bacteriological work and research. The receiver for the flow meter on the plant effluent is located in the hall of the laboratory building. On the roof is the visitors' observation area.

All major equipment, filter tile and filter media were purchased after advertisement direct by the City before the contracts for construction and installation of equipment were let. The cost of the plant, including roads and drainage, will amount to approximately $4,050,922, summarized as follows: Major equipment, such as comminutors, engine-driven pumps, detritors, clarifiers, distributors, and digester equipment, $520,000; 1,750 carloads of 20-cycle filter rock, in place, $438,790; 288,000 sq ft of filter blocks, $108,000; general construction contract, $2,924,132; roads, walks and landscaping, $60,000. Major quantities required are 30,000 cu yd of reinforced concrete; 102,000 cu yd of structural excavation; 2,368 tons of reinforcing steel; and 190,000 cu yd of backfill and grading fill.

The main construction contract was awarded to Earl W. Baker & Co., Oklahoma City, on October 5, 1948, and construction was started December 1, 1948. The plant is scheduled to be completed and ready for operation by January 1950.

Benham Engineering Co. is consulting and supervising engineer for Oklahoma City on its sewerage problems, and Louis R. Howson, M. ASCE, of Chicago, has been retained as consultant.

Assembly-Line Techniques

Speed Construction of Cross-Country Oil and Gas Lines

T. A. HESTER

President, Oklahoma Contracting Co., Dallas Tex.

A TOTAL INVESTMENT in construction equipment of about $1,500,000 and a weekly payroll averaging $100,000—these are some of the figures behind the average progress of 4,000 ft per day on a recent pipeline construction job done by the writer's firm in rough country in West Virginia. These figures include investment and progress for two complete "spreads," or teams of specialist crews. In 17 weeks 90 miles of pipeline was laid. Modern construction equipment and carefully coordinated construction steps performed by specialized crews were the means by which this feat was accomplished. Such speed could not have been achieved thirty years ago, when the pipeline builder transported his entire equipment in a farm wagon. Modern construction methods have made possible the vast mileage of gas and oil pipelines now in operation in this country, and will permit the estimated addition of more than 100,000 miles in the next three to five years. In this article, prepared from the paper presented before the Construction Division at the ASCE Oklahoma City meeting, the author outlines the complex procedure which has been evolved to secure maximum speed and economy in pipeline construction.

PIPELINE CONSTRUCTION of today has come a long way from the farm-wagon and mormon-board methods of thirty years ago. A modern pipeline construction "spread" is a highly mechanized and coordinated team of specialist crews, each crew performing a phase of construction and moving quickly to the next section of pipe. This assembly-line technique has enabled pipeline builders to complete—quickly and cheaply—a job that could not have been even started by the old techniques.

Recently a contract for 90 miles of 24-in. pipe to be laid in the roughest part of West Virginia was awarded to the Oklahoma Contracting Co. of Dallas, Tex. With two "spreads" operating, the job was completed in four months. The operation of each spread was divided into 12 distinct steps.

Crews Work in Planned Sequence

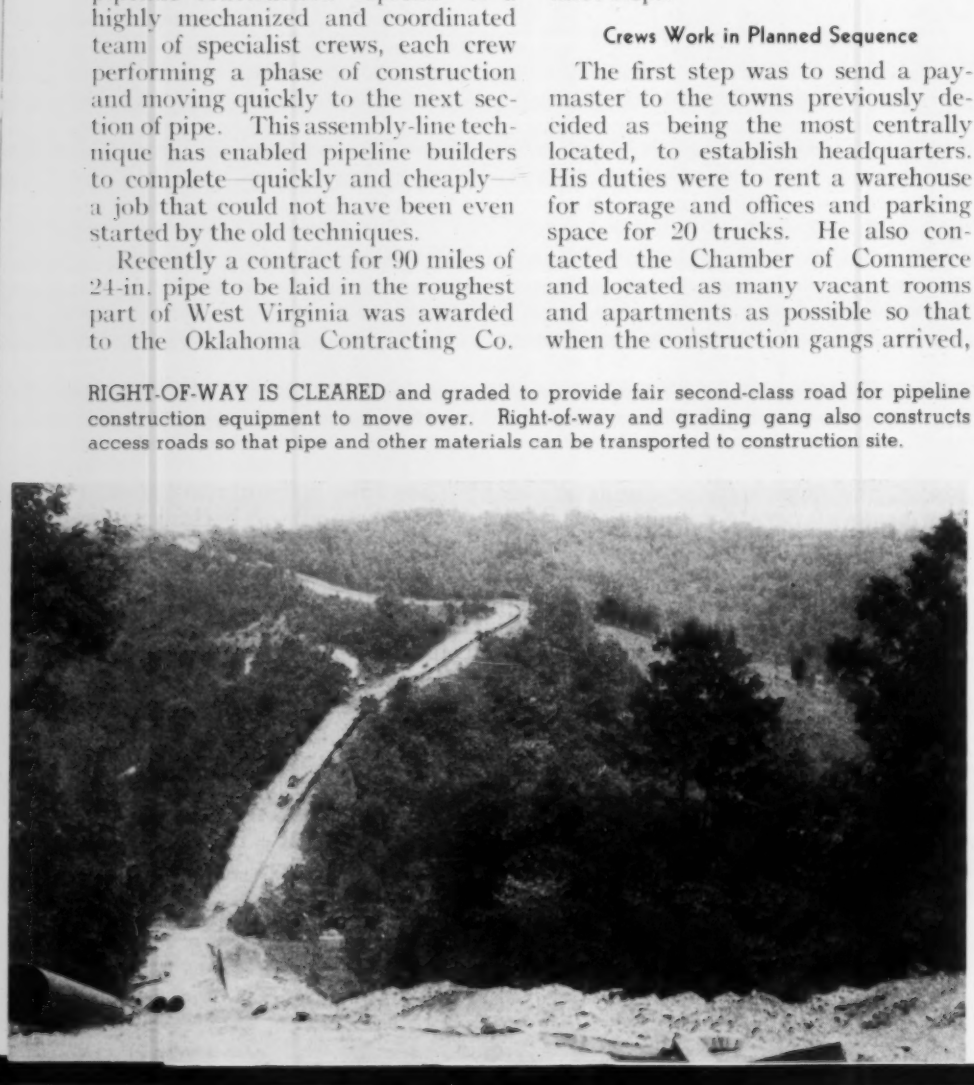
The first step was to send a paymaster to the towns previously decided as being the most centrally located, to establish headquarters. His duties were to rent a warehouse for storage and offices and parking space for 20 trucks. He also contacted the Chamber of Commerce and located as many vacant rooms and apartments as possible so that when the construction gangs arrived, they would have some idea where to start looking for places to live. While the paymaster was accomplishing these things at the headquarters town, about 30 mechanics were checking equipment and loading it out from the home-office warehouse.

Once equipment was on the job, the next step was to start preparing the right-of-way. A small crew consisting of one straw boss and four or five men began making gaps in the fences. These gaps were 75 ft in width to leave plenty of clearance for the equipment to get through. Particular care was exercised in bracing fences before they were cut so that they would be entirely serviceable during the construction period.

Following the fence gang came the clearing gang. This crew consisted of 75 or 80 men with a winch tractor and several power saws. Their job was to cut all the timber flush with the top of the ground, cutting any commercial-size trees into 12-ft log lengths, and trimming and stacking the brush so that it could be burned later. This crew also blasted all stumps directly in the ditch line.

Following the clearing gang, the right-of-way grading gang took over. This gang consisted of four large bulldozers and two air compressors. Their job was to smooth out the right-of-way and make a fair second-class road of it. This operation was particularly difficult because of extremely rough terrain. In addition to making the best right-of-way possible, it was necessary to build approximately 150 "shoo flies" or access roads so that pipe and other materials could be transported to the right-of-way.

RIGHT-OF-WAY IS CLEARED and graded to provide fair second-class road for pipeline construction equipment to move over. Right-of-way and grading gang also constructs access roads so that pipe and other materials can be transported to construction site.



Pipe Unloaded from Railway Cars

After the right-of-way had been prepared in this manner, the unloading and stringing gang started. Its work was to unload the pipe by means of a gin or boom truck from the railway cars onto trucks equipped with semi-trailers, and then to haul it to the right-of-way, where it was unloaded by means of a boom or crane tractor. Large-diameter pipe cannot

CLEANING AND PAINTING of pipe is accomplished by one machine. Pipe is held 2 ft from ground by dollies mounted on tractors which move ahead of cleaning and painting machine. Cleaning is done by series of knives, cutters, and wire brushes which revolve around pipe. Paint is applied by rug, which also revolves around pipe.

be unloaded from trucks by simply rolling it off. The tractor had to pick up each joint and let the truck drive out from under it. This operation was continued until the truck had been unloaded. In addition to the five or six stringing trucks, the gin truck and the side-boom tractor, the unloading and stringing gang used two or three large winch tractors, as it was necessary in many places to tow the trucks up steep grades or through swamps.

After the pipe was strung, the ditching gang started. This gang consisted of about 50 men with two large wheel-type ditchers, six or seven draglines with pull-shovel attachments, six or eight compressors, and hand tools. In good digging there is very little work to do behind the ditchers; however, when rock is encountered, it is necessary to drill and blast after the ditcher has moved ahead. After the rock has been dynamited, pull-shovels straddling the ditch clean out the loose rock. Most of the rock drilled on this job was done with two wagon drills working in tandem. The drills were carried and moved by a D-7 side-boom tractor which also pulled a 500-cu ft compressor. This was quite a departure from our old methods of using single hammer units and proved most satisfactory.

After the ditch was dug, the bending gang took over. The personnel consisted of one engineer, one foreman and 10 or 12 men. Their equipment included two side-boom tractors and one bending machine. Their job was to measure the ditch and the pipe, and to bend the pipe where necessary to fit the curvature of the ground. All bends were made to fit the grade of the ditch exactly. All bends, sags, over-bends and side-bends are made the same way, the pipe being simply turned to fit the ground. The bending machine, a fairly new piece of equipment, saved a lot of time and money. Prior to its invention, bends were made by heating the pipe. This process was slow, expensive and perhaps not too good for the pipe. The new machine cold-bends the pipe while it is held by the side-boom tractor.

After the pipe was bent, the lining-up or laying gang started work. The laying gang consisted of 15 or 20 men, two side-boom tractors, and two welding machines. Their job was to line up the pipe, connecting one joint at a time by running the first bead of the welded joint.

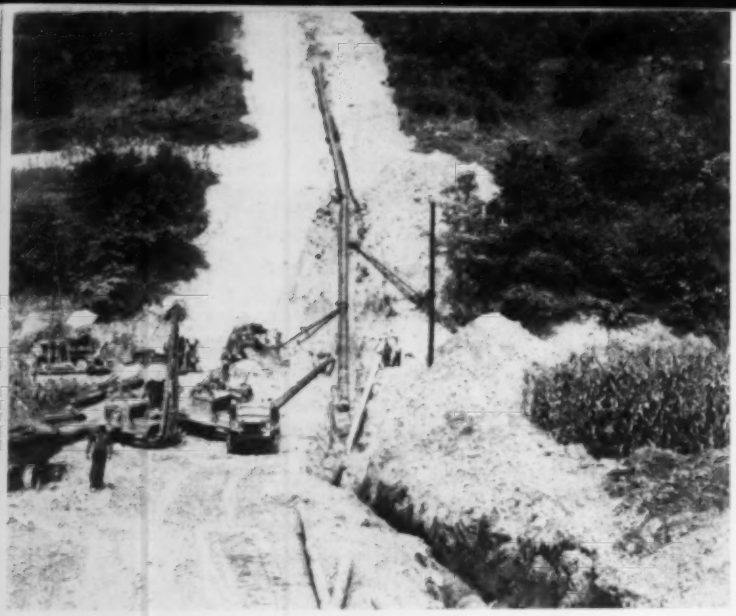
Next, the welding gang, consisting of approximately ten welders, each with a machine, finished the weld started by the laying gang by applying the last two or three beads, depending upon the thickness of the pipe. Each welder was spotted along the line so that he could make three or four welds before he moved forward. The welding machines were mounted on rubber-tired wagons, and the wagons were moved as necessary by means of a tow-tractor.

Combination Cleaning and Painting Machine

After the pipe had been welded, the paint gang began its work. This gang had two large side-boom tractors and a combination cleaning and painting machine. The two tractors carried the pipe on dollies, sometimes called cradles, about 2 ft above the ditch. The tractors moved forward continuously a short distance ahead of the cleaning machine. The cleaning machine has its own traction power, with crawlers on top of the pipe, and is equipped with a series of cutters, knives and wire brushes which revolve around the pipe, removing all mill scale, rust and dirt. Paint is applied by a rug which also revolves around the pipe, the paint feeding in from the top.

After the paint had dried—a process which usually took about three hours—the doping crew followed. This crew had one combination doping and wrapping machine and also two large side-boom tractors. The tractors carried the pipe on dollies in the same way as the paint tractor did. The coating machine traveled along the pipe, applying a thickness of coating varying from $^{3}/_{32}$ to $^{5}/_{32}$ of an inch and at the same time applying the spiral wrapping of asbestos felt or fiberglass onto the hot dope so that the whole protection was completely bonded to the pipe. The dope or enamel was heated in 1,500-gal kettles which were thermostatically controlled. The kettles also had their own power for mechanically agitating the enamel while it was heating. Usually the enamel was heated to 400 deg or

PULL-SHOVEL (near top of hill) is used by ditching gang to remove blasted rock fragments. Wheel-type ditchers do most of trench excavation, leaving only rock outcrops to be removed by pull-shovels following blasting.



SMALL SIDE-BOOM TRACTORS are part of equipment used by lining-up gang, which places pipe lengths and partially welds pipe joints. Welding gang follows and completes welding of joints.

more, depending on the manufacturer's recommendations.

After the pipe had been coated and wrapped, it was lowered into the ditch by the lowering-in gang, which had from four to six large side-boom tractors. The pipe was lowered into the ditch in 600- to 700-ft lengths, leaving about 200 ft on skids above the ditch. These 200-ft sections were called slack loops. Dirt was filled in on the part lowered into the ditch during the day. The next morning before daylight, or before the temperature had risen, the same crew went out and dropped the unlowered portions into the ditch. The purpose of lowering pipe in this manner is to take care of expansion and contraction.

After the slack loops had been lowered, the backfill gang filled the trench, cleaned up the right-of-way and repaired the fences. Cleaning up the right-of-way means rounding terraces, filling in cuts made by the right-of-way gang, and generally leaving the right-of-way in a neat and clean condition—as nearly as possible in the same condition as it was before construction started.

Progress Averages 2,000 Ft per Day per Spread

On this job there was a total investment in construction equipment of approximately $1,500,000, and the weekly payroll averaged $100,000. The job lasted 17 weeks and averaged about 2,000 ft per day per spread. In reasonably level country the average progress was much more.

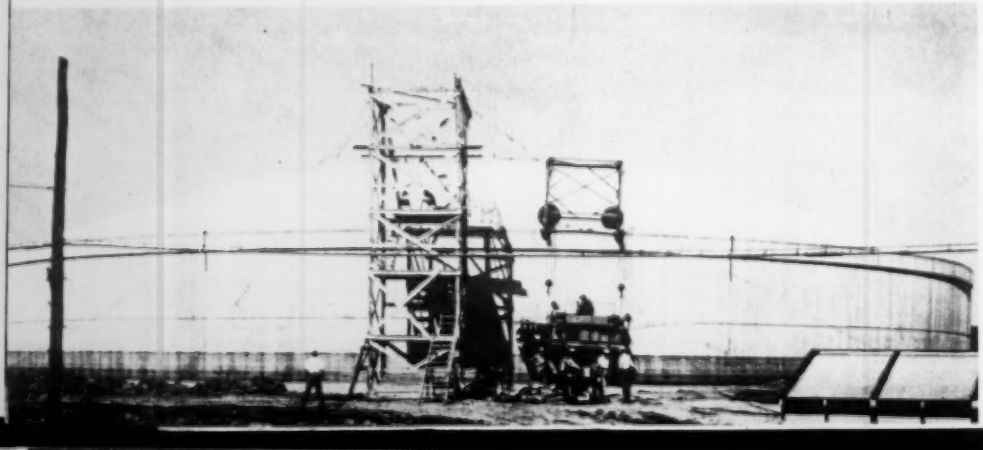
Before final acceptance of any pipeline by the owner, some type of test may be required. The line may be tested and cleaned in sections during construction or tested and blown clean after completion. Hydrostatic pressure, gas or air pressure may be used for testing. Air pressure and soap-bubble tests are sometimes used. Running scrapers or "pipe pigs" to clean and check the line may be required, depending upon the size of the line and other conditions, and the wishes of the owner.

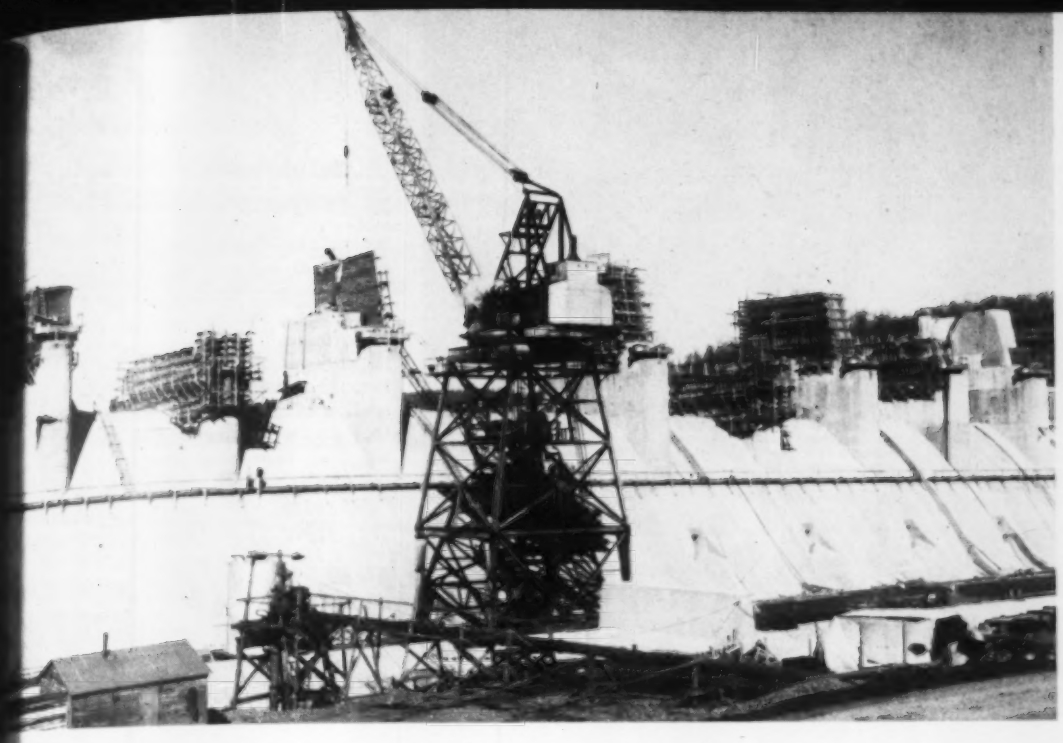
Construction in the field is directed by a small group of highly trained and experienced personnel. This field office handles the important details of spending from $10,000 to $12,000 per day. The usual field office force consists of a superintendent or general foreman, a paymaster (who in reality is the office manager), a timekeeper, and two time-checkers. Time is kept in the field and mailed to the main office weekly, where checks are made up and mailed to the paymaster for distribution to the men.

A great need for assistance from the engineering profession developed with the change from simple manual methods of pipe laying to mechanical procedures. The manner in which this need has been met by the ingenuity of the pipeline builders and their engineers is evidenced by the vast improvements in pipeline construction technique and equipment in recent years, and the increased use of pipelines as a means of transportation. Good supervision, diligence, and ingenuity are prime requisites for a successful pipeline construction organization and provide a field rich in opportunities for the construction industry and the engineering profession.

Continuously Wound Wire Prestresses 180-Ft-Dia Concrete Water Tank

USE OF WIRE for prestressing concrete in tanks to contain liquids is relatively new development in this country although a number of tanks have already been built by this method. Recently 4-million-gal water tank of this type was completed in Kansas City, Kans., for city's Board of Public Utilities. Unreinforced concrete wall was first poured in separate sections to full height of tank—19 ft 6 in. Tank was then wrapped with cold-drawn wire (210,000 psi ultimate) by special rig, called "Preloader." Wire was stressed to 140,000 psi as it was wrapped by being drawn through a die, each layer being covered with Gunite after it was placed. Vertical rods on inside of tank, spaced 2 ft on centers, were stressed to 70,000 psi by turnbuckles as the external layers were applied. Dome ring at top of wall was wrapped with wire (seven layers) before dome load was transferred from forms to wall. The 180-ft-dia dome is unsupported. Consulting engineers for project were Burns & McDonnell, Kansas City, Mo. The Preload Enterprises, Inc., of New York, made designs and supervised prestressing operations. General contractor was Inter State Construction Co., Kansas City, Mo.





CRANE RUNNING ALONG downstream side of Fort Gibson Dam places forms for spillway monoliths. Crane also places concrete, taking buckets from Euclid trucks which have been loaded at batching plant near east abutment. Net spillway length, exclusive of twenty - nine 10 - ft-wide bridge piers, is 1,200 ft.

Automatic Batchers Add Ice to Concrete Mix for Fort Gibson Dam

C. H. CHORPENING, M. ASCE

Colonel, Corps of Engineers; District Engineer, Tulsa District, Tulsa, Okla.

CONCRETE PLACEMENT at the average rate of 1,000 cu yd per eight-hour shift is now under way on the spillway section of Fort Gibson Dam, located on the Grand (Neosho) River about five miles northeast of Fort Gibson and about 12 miles northeast of Muskogee, Okla. The dam is being built by the Corps of Engineers, Tulsa District, for the multiple purposes of flood control, hydroelectric power generation, supplemental water supply and recreation. Both the power and flood control pools will extend upstream for a distance of about 39 miles, to the Markham Ferry Dam site. Still further upstream is the Pensacola Dam site. All three dams when completed will be operated as a unit for maximum flood control benefits in the Arkansas River Valley downstream of the Grand (Neosho). The Fort Gibson Dam is scheduled to begin water storage for flood control in the summer of 1951 and hydro power generation in 1953. This article is based on Colonel Chorpening's longer paper presented before the joint session of the Construction and Sanitary Engineering Divisions at the ASCE Spring Meeting in Oklahoma City.

UNUSUAL FEATURES marking the construction of Fort Gibson Dam in Oklahoma include the manufacture of about 180 tons of ice a day at the site for addition to the concrete mix at the batching plant. By this means the mix is kept at a temperature between 50 and 60 deg F when it is delivered to the forms. About 1,800 cu yd of concrete is the average daily placement rate in the spillway as of April 15.

Ice is added to the mix at the rate of 100 to 300 lb per 2-cu yd batch, depending on the temperature of the aggregates and the air. The ice is manufactured by three Vogt automatic tube machines, each capable of producing 60 tons of ice daily, plus a 10-percent overload. The method of adding ice to the mix was utilized for this dam because it was determined to be cheaper than the use of circulating water in view of the rates of placement and the size of the monoliths.

Batching Plant Fully Automatic

The batching plant is a fully automatic Johnson model, one of the first of its type to be installed. It automatically weighs out nine different materials for 2-cu yd batches, varying from a few ounces of air-entraining admixture to a ton of cobbles at one time. Each material is weighed independently in the batching plant and then dumped into a common hopper. From the batch hopper a rotating spout discharges into four 2-cu yd Koehring mixers. The specifications require the mixing plant to have a capacity of 1,200 cu yd per eight-hour shift.

Sizes of aggregates vary according to the destined position of the concrete in the dam. For thin sections (10 in. or less), such as walls, floors and roofs, the aggregate size is limited to a maximum of $^3/_4$ in. For the spillway bridge, temporary bulkheads and the upper part of the spillway piers, the maximum size is $1^1/_2$ in., whereas in training walls, retaining walls and stilling-basin slab it is 3 in. Mass concrete, used in the abutment and spillway sections, contains aggregate up to 6 in. in size.

Mass concrete contains the equivalent of $4^1/_2$ bags of cement per cu yd for exterior portions (minimum thickness of 5 ft) and $3^1/_2$ bags per cu yd for the interior portions. Laboratory tests show a 28-day compressive strength of about 4,500 and 3,700 psi respectively for the exterior and interior mass concrete.

Concrete is transported from the mixers in 2- or 4-cu yd buckets mounted on Euclid trucks, two buckets to the truck. A traveling crane transfers the buckets from the trucks to the forms. Forms are of tongue-and-groove stock, usually 2 in. thick, with steel walers as required.

The specifications require that the first four courses of the monoliths,

GRAND (NEOSHO) RIVER FLOWS through 290-ft-wide section of spillway of Fort Gibson Dam while concrete is placed in spillway monoliths (far left). Construction view from east abutment also shows completed non-overflow and powerhouse intake sections at right and concrete batching plant in left foreground. Later river flow will be diverted through ten sluices and flood flows, if any, through powerhouse intakes, while center section is built up. Following reservoir relocation work, powerhouse will be constructed, permitting release of flood flows over spillway.

over 1,000 sq ft in horizontal area, starting from the foundation or from lifts which have been in place longer than 15 days, shall be limited to a maximum height of $2^1/_2$ ft. The remaining courses and lifts of the gravity sections are limited to a thickness of 5 ft, and the maximum differential in height between adjacent monoliths is limited to 25 ft, except in the case of low monoliths utilized for diversion purposes. The concrete is vibrated by air-operated vibrating equipment supplemented by hand spading.

Curing is accomplished by membrane compound on vertical surfaces with clear curing compound on all exposed faces and black curing compound on all unexposed vertical surfaces. Water curing is utilized on all horizontal surfaces with the exception of trowel or float finishes, which are cured with membrane compound. For cold-weather operations, the specifications require that the air in contact with the concrete shall be maintained at temperatures between 50 and 70 deg F by suitable covering and heating for at least the first five days, and at a temperature above freezing for the remainder of the curing period.

Aggregate Plant Designed for Dependability

The aggregate plant is capable of producing 1,400 tons per eight-hour shift with a 20-percent waste factor. The plant has two parallel production lines and produces five different sizes: Crushed rock sand up to No. 4 size; No. 4 to $^3/_4$-in. rock; $^3/_4$-in. rock; $^3/_4$- to $1^1/_2$-in. rock; $1^1/_2$ to 3-in. rock; and 3- to 6-in. rock. Most of the dust under the 100-mesh size is removed by dry-process air separators. Storage bins with a total capacity of 1,430 tons, together with two 3,300-ton stock piles of partly processed materials midway in the flow cycle, and emergency alternate routes in the system, insure dependability of production.

Equipment utilized to produce the aggregate is as follows: One roll and five jaw crushers; three hammer mills; two dust separators; two rotary scrubbers; ten double-deck screens (two with spray bars) from $3^1/_2 \times 5$ ft to 4×12 ft in size; 1,991 ft of belt conveyors in 26 flights, 24 and 30 in. wide, from 3 to 128 ft long; one reciprocating and four apron feeders; one 16-ft bucket elevator; 16 bins from 30 to 150-ton capacity each (1,430 tons in all); two intermediate stock piles with two reclaiming tunnels; 31 electric motors from 5 to 200 hp, totaling 850 hp; six diesel engines, totaling 600 hp; a transformer bank; two electric control stations; and two pumping plants. All aggregate is transported to the dam by truck. The aggregate plant was designed by George C. Hawkins, consulting engineer for M. O. Weaver, Inc., aggregate subcontractor.

In the search for sources of aggregate, two limestone quarries near the site were originally considered for coarse aggregate, and natural sand from the Arkansas River was considered for fine aggregate. Although these materials were found to be in conformity with the usual qualitative tests, subsequent more intensive tests, including petrographic examination and freeze-thaw tests made on concrete in which the aggregates were incorporated, indicated that the limestones contained potentially unsound materials. Also neither of the two original sources of limestone or others subsequently investigated would, in combination with natural sand, meet the requirements of the accelerated freeze-thaw tests made on concrete containing the various aggregate combinations. The reason was probably wide differences in the coefficients of thermal expansion of the coarse and fine aggregates. To remedy this situation, it was decided to utilize limestone for both the coarse and the fine aggregate.

After extensive additional explorations, the present limestone quarry was located in the Morrow formation on the left abutment about four miles east of the dam. Limestone from this source contains practically none of the unsound materials previously encountered, and the combination of coarse and manufactured

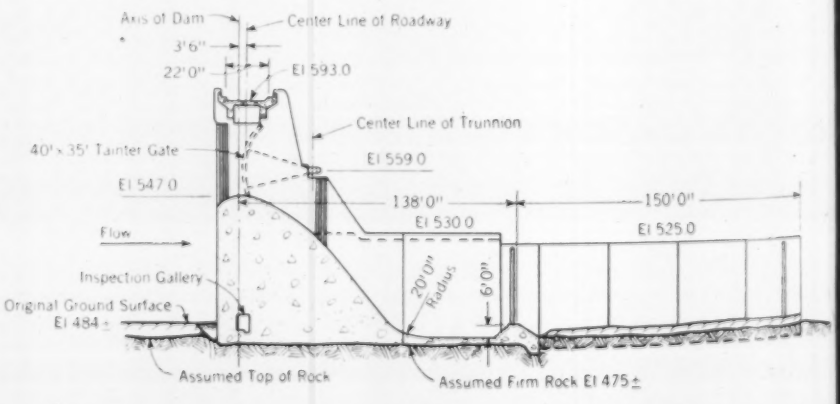


FIG. 1. TYPICAL CROSS SECTION through spillway of Fort Gibson Dam shows main features of design. Maximum height of dam above foundation is 135 ft.

CONTRACTORS' WORK AREA, below dam on east side of river, contains aggregate storage area and batching plant, with cement storage silo and rectangular tower for ice machines—with compressors and mechanical equipment in quonset at far left. Ice is fed by gravity to batching plant. Railroad cars bring cement to storage silo, and trucks, center distance, dump aggregate into storage piles, whence it travels by belt to batching plant.

fine aggregate from the same source successfully withstands the severe accelerated freeze-thaw test.

All construction work at Fort Gibson Dam and Reservoir is being done under contracts which are divided into four separate categories. These are: Government buildings and the 5.75-mile access road from Okay, Okla., to the site; the dam and related facilities; the powerhouse and switchyard and the installation of power-generating equipment; and the relocation or alteration of utilities in the reservoir area, as well as clearing of timber in the permanent or power pool.

War Delays Construction

The work in the first category was completed under a contract initiated in 1942, before the project was placed on a standby status because of the war emergency. The work in the second or principal contract is now under way. This contract, for $14,736,000, includes the construction of the dam and spillway, power intake structure, elevator and stair tower and water storage tank; and furnishing and installation of sluice, tainter and penstock gates and other appurtenances. It was let on May 4, 1946, to the joint venturers Al Johnson Construction Co., Winston Brothers, and Peter Kiewit Sons' Co. As of the end of April, work under this contract is 82 percent complete. Completion is scheduled for February 12, 1950.

The project as a whole is 44 percent complete. It is expected that the reservoir will be placed in operation for flood control in the summer of 1951 and that the entire project, including power generating equipment, will be in operation in 1953. Plans and specifications for the powerhouse and the switchyard are now being prepared under a contract with the Fargo Engineering Co. of Jackson Mich., and a contract for the construction of these facilities will be let separately to provide an initial generating capacity of 49,200 kw in four 12,300-kw units.

Work on the present contract, for the dam and appurtenant works, has been divided into three phases. In the first stage, now completed, a cellular cofferdam was extended toward the river channel from the left bank, leaving the river flow in the original channel. The cofferdam was constructed to a minimum top elevation of 530 and 520 ft mean sea level for the upstream and downstream arms respectively, with the connecting arm stepped between these elevations. When excavation and placement of approximately 378,000 cu yd of concrete were completed within the protected area on the east bank, the first-stage cofferdam was removed and the second-stage cofferdam was placed around the river-channel area, and an embankment cofferdam was extended to the right bank. Grouting of the foundation from the gallery on approximately 10-ft centers, is now under way. Diversion of stream flow during this second stage is being made through a 290-ft-wide section of the spillway.

When the excavation and concrete placement under this stage are completed, the third stage will be commenced by closing the opening in the spillway and diverting the stream flow through the ten sluices. Flood flows, if any, will be diverted through the powerhouse intakes. The powerhouse will be constructed on completion of relocation work in the reservoir, which will make possible the release of flood flows over the spillway.

The concrete intake section for the hydroelectric power facilities, which is 318 ft long, is included in the present contract. It is located on the left-bank flood plain adjacent to the existing river bed. Six twin penstocks, 14 ft 6 in. × 18 ft, with invert elevations at El. 511.5 will be provided. Eight caterpillar-type vertical-lift gates, operated by individual electric-motored hoists, will be installed to regulate flow to the turbines, while the other four conduits will be temporarily closed with destructible concrete bulkheads. The present contract also includes installation of trashracks, trashrack raking equipment and slots for emergency bulkheads.

Major items of work under the present contract include: 550,000 cu yd of common excavation and 96,000 cu yd of rock excavation; 304,000 cu yd of common fill; 37,500 cu yd of rockfill and dumped riprap and 10,000 cu yd of derrick stone; 500,000 cu yd of concrete and 2,655,000 lb of reinforcement steel; 51,000 lin ft of foundation grouting; 18,000 lb of copper water stops and 15,000 lb of rubber seals; Tainter gates and anchorages weighing 4,021,000 lb; emergency gate guides, power intake and trashracks and guides totaling 645,000 lb; and 570,000 lb of miscellaneous metalwork, pipe and castings.

Flood Control Advantages of Site

The Grand (Neosho) River is one of the principal flood-producing tributaries of the Arkansas River. The watershed has an area of 12,660 sq miles, which is about 27 percent of the contributing drainage area of the Arkansas River above Muskogee. Hydrologic studies indicate that the Grand (Neosho) River contributed about 60 percent of the peak flows in the Arkansas River at Muskogee during the maximum flood of May 1943 and the second highest flood of October-November 1941, and about 45 per cent of the total volumes of these floods at that point. The drainage area above Fort Gibson Dam is 12,615 sq miles, so that control of runoff from over 99 percent of the entire Grand (Neosho) River basin is obtained.

At top power pool the reservoir shoreline will extend 225 miles and the area of the permanent or power pool will be 19,100 acres (at El. 554 ft mean sea level). An additional area of up to 31,900 acres will be utilized for temporary storage of flood waters (to El. 582 ft). The total storage capacity of the reservoir is 1,287,000 acre-ft, of which 922,000 (71.7 per-

BUCKET AND CRANE place 350,000th cu yd of concrete in Fort Gibson Dam on January 4, 1949. As of April 15, average daily placement rate in spillway is about 1,800 cu yd.

cent) is for flood control between Els. 554 and 582, and 365,000 is pondage, with only nominal drawdown between Els. 554 and 551 for the development of hydroelectric power.

Fort Gibson Reservoir will be operated in conjunction with the Pensacola and Markham Ferry reservoirs (to be located upstream) as a unit in the system of authorized projects in the Arkansas River Valley for maximum flood-control benefits on the Arkansas River downstream from the Grand (Neosho).

Fort Gibson Reservoir will require alteration or relocation of about 46 miles of highways, 48 miles of railroads, a new water supply intake structure and pumps for the city of Wagoner, Okla., 21 miles of power lines, 49 miles of telephone lines, and protection for the waterworks of the city of Pryor. About 32 cemeteries will be affected. Portions of major highways will be raised or relocated in such a way as to maintain the present flow of traffic on each side of and across the reservoir area. The most outstanding highway relocation concerns Oklahoma State Highway No. 51 between Wagoner and Hulbert, Okla., which will cross the reservoir area at approximately its present location. Contract for construction of 12 miles of this relocated highway, including a bridge over Grand (Neosho) River composed of five 210-ft truss spans, was awarded on October 7, 1947, at a contract price of $1,783,839. Plans have been completed for alteration of about 3.3 miles of asphalt-surfaced Okahoma State Highway No. 33 near the upper limits of the reservoir, and plans are now being prepared for relocation of 6.3 miles of concrete-paved U.S. Highway No. 69, on the west side of the reservoir, and other roads similarly affected.

The latest estimated cost of Fort Gibson Dam is $46,646,000, of which $30,160,000 is for construction and $16,486,000 is for lands, damages, and relocations.

Design of Fort Gibson Project

The design procedure of the Corps of Engineers normally passes through three definite and separate stages following an authorization by Congress for preparation of a report. These consist of survey report studies, advance planning, and preparation of contract plans and specifications.

The survey report on the lower Grand (Neosho) River, published in 1939 as House Document No. 107, contains comparative data for a flood-control-only project at the Pensacola site; for generation of hydroelectric power only in Pensacola, Markham Ferry, and Fort Gibson Reservoirs; and for combined purposes of flood control and generation of hydroelectric power in the three-reservoir system. The latter plan was elected as producing the maximum practicable development for beneficial water use and control of destructive floods in the Arkansas River Valley. Construction of the three reservoirs for the dual purposes of flood control and power generation was authorized by Congress in the 1941 Flood Control Act.

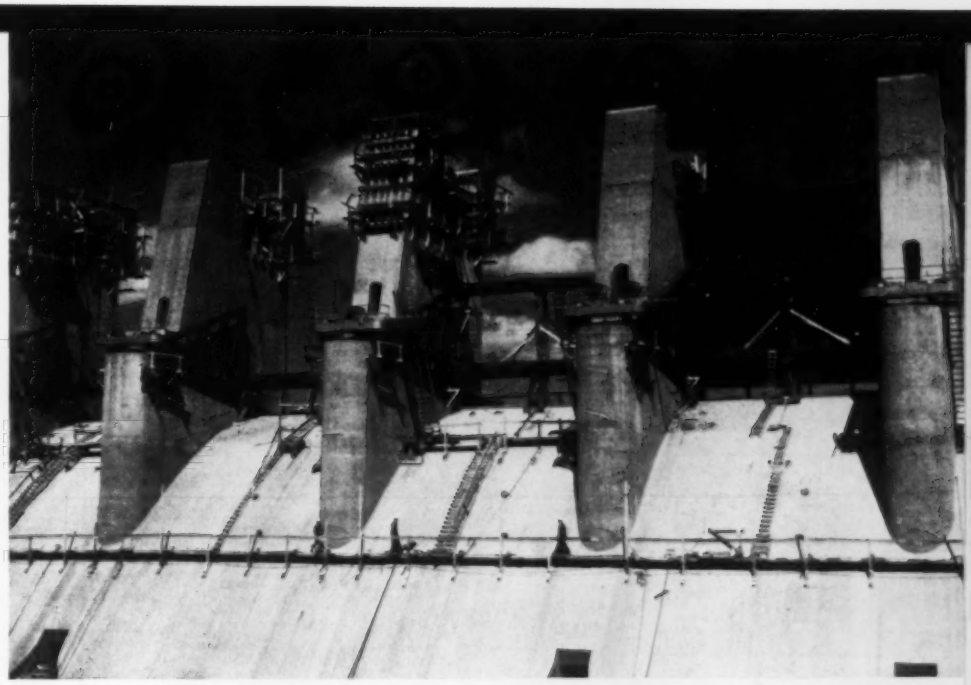
The second stage of design follows authorization of a project by Congress and appropriation of funds for advance planning. This stage includes model studies, hydrologic and hydraulic investigations, geologic and subsurface explorations, soil analyses, investigation of construction materials, and more detailed design of the various features. The Board of Consultants, formed to review and suggest possible modification for the proposed plan for Fort Gibson Dam was composed of nationally recognized consultants, as follows: Joel D. Justin, Horace S. Hunt, James P. Growden, L. F. Harza, and W. H. McAlpine, Members ASCE. Personnel of the Office, Chief of Engineers, who participated in the proceedings of the Board included Gail A. Hathaway, T. A. Middlebrooks, also members of ASCE, and E. B. Burwell, geologist.

The third stage of design consists of preparation of contract plans and specifications incorporating suggestions by the Board of Consultants, and revisions outlined by higher authority within the Corps of Engineers.

Because of the extremely large peak flow and volume of floods which originate on the Grand (Neosho) River, it was necessary to fully develop the storage at the Fort Gibson site. The flood plain at the damsite is approximately 2,200 ft wide, largely composed of gravel deposits covered with sandy clay silt. The maximum depth of the alluvium on both banks is about 40 ft, into which the river channel has been incised to a depth of about 25 ft. The valley sides rise over 250 ft above the average elevation of the flood plain and the maximum height of the dam above the foundation is 135 ft.

The valley in the project area is formed in and underlain by a series of Pennsylvanian and Mississippian shales, limestones, and sandstones, which have been elevated, gently folded and faulted as a result of the Ozark uplift, and now form a dissected plateau, tilted gently to the southwest. No faults have been discovered in the site area.

A bed of moderately hard, dense limestone, 16 ft thick, just beneath the bedrock surface of the flood plain forms the foundation for the high-dam section across the greater part of the valley. Coarse-grained shales which underlie this limestone will be utilized for the foundation where it is necessary to remove or go below the limestone bed. A thin lens of shale above the limestone, with a maximum thickness of 5 ft, forms bedrock across the greater part of the valley and will be excavated to the underlying limestone in areas of concentrated heavy loads, but will be utilized as the foundation for light structures, such as the stilling basin. Both abutment sections will be founded partly on the limestone bed and partly on shales.



INSTALLATION OF TAINTER GATES on Fort Gibson Dam proceeds from east toward west abutment. To provide operating flexibility, thirty 40×35-ft-high individually operated gates are mounted on top of weir crest at El. 547, or 7 ft below top of power pool. For maximum flexibility of operation, ten 5-ft 8-in.×7-ft sluices have been provided in spillway weir. Flows through sluices would be controlled by hydraulically operated cast-steel slide gates.

Four possible axes were investigated for the dam. Additional foundation explorations consisted of three lines of core borings, one along the axis of the dam, and one along offsets located 200 ft upstream and downstream from it. Sampling equipment recovered rock cores of 5⅜-in. nominal diameter from about half of the axis core holes. The remaining cores had a 2½-in. nominal diameter.

Concrete Gravity Type Dam Selected

The investigations indicated that suitable materials would be available for either an earthfill or earth- and rockfill dam but because of the length of the spillway and powerhouse intake structure a concrete gravity dam was selected with adequate embankment ties at each abutment. The earth embankment section on the right abutment was selected to avoid excessive excavation to unweathered foundation which would have been required had the concrete section been extended entirely to the right abutment. The spillway structure is designed to pass 926,000 cfs at maximum pool elevation, which allows for possible synchronization of flows from the Pensacola and Markham Ferry Reservoirs, occurring on top of a full flood-control pool at the Fort Gibson Reservoir.

Because of the relatively narrow valley, compared to the required length of spillway and powerhouse structures, and the high abutments, the river channel and flood plain is the only topographically favorable location for the spillway. These conditions, together with the depth and nature of the foundation rock, dictated a concrete gravity, ogee spillway structure (Fig. 1).

Laboratory tests indicated that maximum allowable base pressure on the foundation should be limited to 50,000 lb per sq ft on the limestone and 20,000 on the shale. However, the maximum pressure developed under the most adverse loading conditions amounted to 14,000 lb per sq ft on the limestone and 12,000 on the shale. Cohesion to resist shearing forces on the foundation was limited to 45,000 lb per sq ft on the limestone and 10,000 on the shale. The minimum factor of safety with respect to resistance to sliding in terms of horizontal forces was 3.7. The maximum ratio of horizontal to vertical forces acting on the abutment sections was 0.61.

Structural design requirements for the spillway are essentially the same as for the abutment sections. The maximum foundation pressure developed under the most adverse loading condition amounted to 11,500 lb per sq ft, and the minimum factor of safety against sliding was 12.9.

Design of the stilling basin was unique in that, at all discharges, the natural tailwater depths were much in excess of those required for the formation of a hydraulic jump on a level apron set on foundation rock. At maximum spillway flow, the excess depth of tailwater is 22 ft. Because of the lack of similarity in hydraulic conditions to spillways previously built or tested by hydraulic models, model tests were conducted at the U.S. Waterways Experiment Station at Vicksburg, Miss. A satisfactory and economical stilling basin was obtained, consisting of a short horizontal apron joined to the spillway weir face by a 20-ft-radius bucket curve and terminated at its downstream end by a 6-ft-high stepped end-sill. The apron length is 70 ft over that portion of the spillway containing the sluices and 50 ft elsewhere.

Powerhouse Equipment Being Manufactured

Design of the powerhouse and appurtenant structures was undertaken during the war and, for that reason, many economies in space and material were adopted to save what was then critical material. However most of these that would aversely affect either cost or convenience were subsequently eliminated.

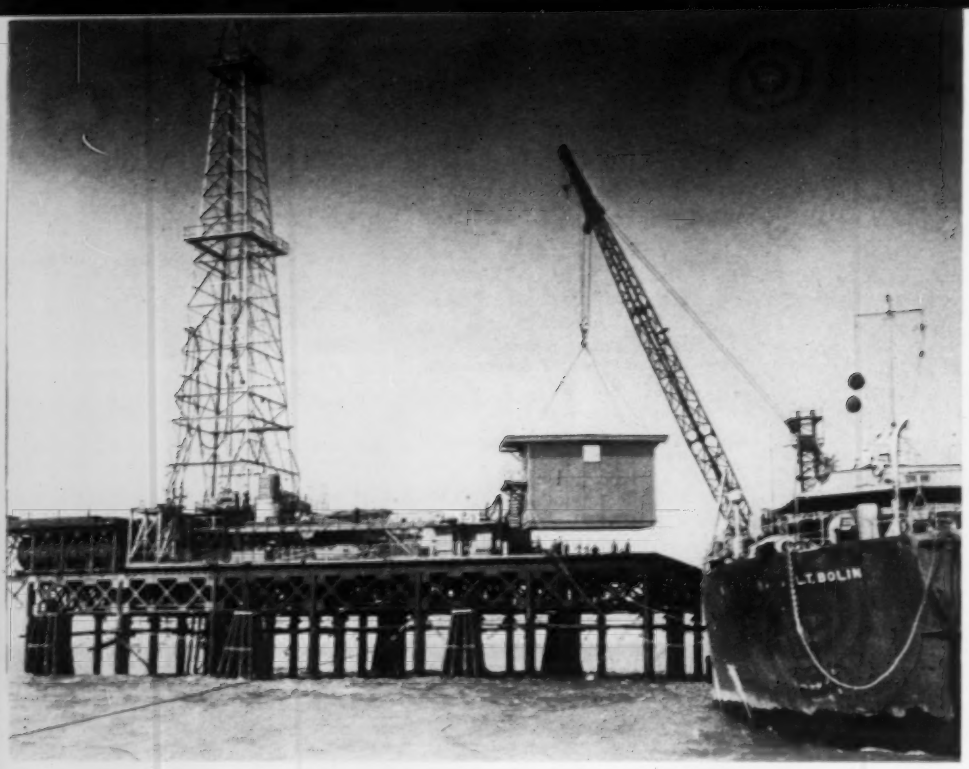
Turbines, which are being manufactured by the I. P. Morris Division of the Baldwin Locomotive Co. at Eddystown, Pa., consist of four 20,000-hp Francis-type rotating at 100 rpm. With releases from the power pool due to normal power generation, the tailwater would not exceed El. 495 ft. The turbines would be set with the center line of the distributors at El. 500 ft, to limit severe cavitation. A governor capable of closing (or opening) the wicket gates in three seconds' actual travel time is being provided for each of the four units.

Four 60-cycle 100-rpm generators are being made by the Allis Chalmers Manufacturing Co. of Milwaukee, Wis. The normal voltage will be 13,800 v and the power factor 0.95. The nominal or name-plate rating will be 12,500 kva.

Prime, or 100-percent-of-the-time, power is 9,000 kw with an average net regulated flow from Pensacola and Markham Ferry Reservoirs during the most critical dry period of 2,060 cfs. Under normal operating conditions, the average net power head would be 59 ft, with a maximum of 61 ft and a minimum of 58 ft. The total installation will generate 180,700,000 kwhr annually, of which 78,800,000 kwhr is primary energy and 101,900,000 is secondary energy.

The wide spread between the prime power of 9,000 kw and the installed capacity of 73,800 kw is desirable because the short-time peaking capacity is useful in the system into which the plant will feed.

Construction of Fort Gibson Dam is under the supervision of M. W. Parse, Director, Construction Division, Tulsa District. F. M. Newell, Corps of Engineers, is Resident Engineer, and O. S. McCormick is superintendent of construction for the Al Johnson Construction Co., Winston Brothers, and Peter Kiewit Sons' Co.



LARGE OIL-DRILLING PLATFORM 7 MILES OFFSHORE rests on 36 pipe piles of 30-in. diameter. Prefabricated living quarters were constructed in Houston. One of three sections is shown being placed by crane. Two-story structure was divided into sections to permit handling by 50-ton crane. Platform was built for Stanolind Oil and Gas Co.

Sea-Going Construction Plant Drives Huge Pipe-Piles to Close Tolerances

M. P. ANDERSON, Assoc. M. ASCE
Chief Engineer, Brown & Root, Inc., Houston, Tex.

DRIVING 30-IN. PIPE PILES in open sea to tolerances close enough to fit them to prefabricated trusses for offshore oil-drilling platforms, was accomplished by mounting heavy land-construction equipment on a sea-going craft. The ship, a surplus Navy lighter, although not self-propelled, was equipped to generate both steam and electric power for the construction equipment on board. On it's square stern, ideal for driving operations, was mounted a 60-ft tower supporting open-top swinging leads. Its long, flat deck provided ample room for the self-propelled gantry with revolving crane. The platform supports a complete oil-drilling rig with a 136-ft derrick and a two-story barracks to quarter the men. The structure rests on 36 open-end pipe piles, 30 in. in diameter, driven to a penetration of 100 ft. All connections are welded. An article describing another well-drilling platform in the Gulf, but resting on H-piles, appeared in the July 1948 issue of CIVIL ENGINEERING. Mr. Anderson's article is based on the paper he presented before the Construction Division at the ASCE Spring Meeting in Oklahoma City.

CONSTRUCTION of welded-steel oil-drilling platforms by driving large-diameter pipe piling in the open waters of the Gulf of Mexico was once viewed with considerable misgiving by both engineers and construction men. This was especially true when the spacing and alignment of these piles had to fall within close tolerances to permit the erection of prefabricated steel trusses and other structural members of the steel platforms.

The platform described herein was constructed for the Stanolind Oil and Gas Co., by Brown & Root, Inc., Marine Operators. It is located about 7 miles off the Louisiana coast some 12 miles east of Sabine Pass, in a depth of water of 33 ft.

The structure stands 28 ft above the normal water level and is designed to withstand hurricane winds and wave forces. Plan dimensions are 80 × 193 ft, providing space for the 136-ft derrick, pipe rack, numerous tanks, the rotary, draw works, mud pumps, diesel engines and living quarters—a total live load in excess of 5 million lb, which is transmitted through a system of floor beams and trusses to 36 pipe piles. Piles are generally spaced 30 ft on centers although 15-ft spacing is necessary in some areas of weight concentration.

Piles are 30 in. in diameter with a wall thickness of $^{5}/_{8}$ in. and a maximum length of 130 ft. A penetration of about 75 ft below Gulf bottom provides adequate bearing for the maximum loading of 200 tons per pile. The piling is braced under water both transversely and longitudinally by a system of heavy cables attached to the piles. These cables extend from a point on the pile below the mud line diagonally upward and are connected to the pile caps just below the trusses. Turnbuckles are used to tighten these cables.

Equipment Carried on 260-Ft Barge

The work boat or barge carrying the pile driver and crane must have sufficient stability to permit operations in small waves and must also be able to weather sudden blows of considerable magnitude. For this service the company was able to secure a surplus Navy lighter or barge of the YF class. This barge has an over-all length of 260 ft, a beam of 48 ft and measures 15 ft from keel to main deck. It is not self-propelled. The bow is raised and

conventionally shaped and the stern is square. Cargo space is provided above and below the main deck in a house extending the full length of the ship. Crew quarters are forward in the bow.

In converting the vessel for its new service most of the deck house was removed to provide space for construction equipment and open storage, leaving just enough of the house for berthing and feeding some 50-odd men, ten of whom comprise the normal ship's crew. A number of these vessels were used during the recent war as general cargo barges for ocean service.

Full-length conventional leads for driving the long piles were considered impracticable because of the length of the leads required, the magnitude of the lead tower, the wind resistance and the over-all effect on the stability of the barge. Therefore 60-ft open top leads supported on the stern by a tower of like height were adopted. The leads were hinged to provide adjustment laterally, and the tower was hinged to provide adjustment in alignment fore and aft to compensate for listing of the barge. Hinged collar clamps located top and bottom on the lead hold the pile in place at the start of driving.

Revolving Crane Mounted on Gantry

A revolving crane for handling piles and hammer and for general service were located just behind the lead tower. This crane, mounted on a self-propelled gantry, was equipped with a 120-ft boom and has a lifting capacity of some 50 tons. The gantry clears the deck by 7 ft, leaving storage space beneath for piling. The wheel trucks were removed from this gantry and a special arrangement of rollers was substituted to provide a 50-ft movement along the deck. This alteration makes a less cumbersome arrangement and is considered more stable than truck mounting. Provision was made for lashing the crane to the deck and for securing the boom horizontally in a U-shaped rest—a necessity in heavy seas.

A 125-hp boiler for supplying steam to the hammer and winches, a 400-kw a-c generator furnishing power for the crane, and two d-c generator units supplying power for the ship's facilities and the pumps (part of the ship's original machinery), are located below deck. The ship's original bow anchor and winch were used without alteration. In addition, four 5,000-lb anchors with the necessary steam hoists were installed for securing the barge at the site of the work. The wire-rope lines for these anchors are arranged to fan out at angles of 45 deg to the ship's longitudinal axis, two at the bow and two at the stern. This work boat, once loaded and at the site, is a self-sufficient unit. Construction materials for which there is not room on the initial trip are brought out on barges.

Barge Positioned by Triangulation

After the location of the oil structure had been determined by geophysical methods, engineers fixed the point by triangulation from two transit stations located on shore many miles away. Direct radio communication between these stations and the construction barge was used to guide the vessel to position.

When the approximate position was reached, the bow anchor was dropped and the barge allowed to swing into the wind. The attending tugboat picked up each of the four maneuvering anchors in turn, carried it out about 1,000 ft and dropped it. A pile, placed in the leads, was used as a sighting mast for the transit stations. This first pile was a specific one, usually at a corner, and when driven served as a reference point for the location of the remaining piles. When the position of this pile was approved by radio, the pile was lowered and allowed to sink of its own weight into the floor of the Gulf, and then driven to the required depth.

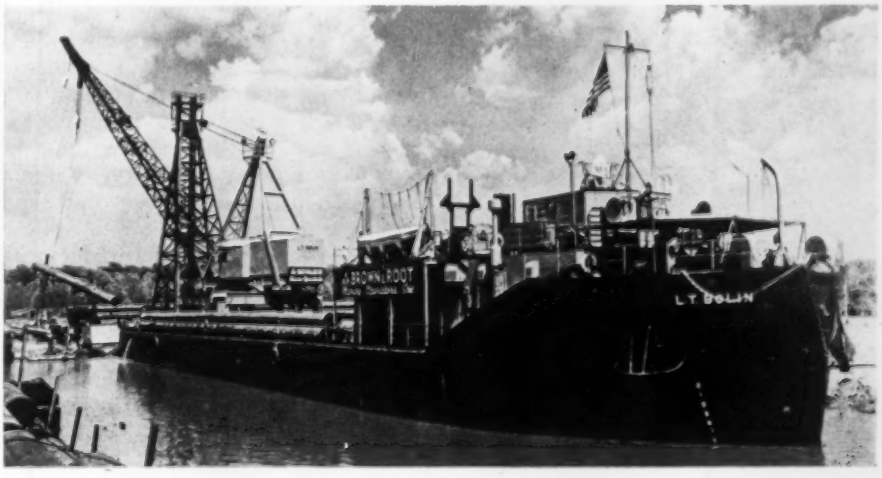
The crane boom, which extended about 100 ft above the water, was used to place the hammer on top of a pile. This distance, plus the depth of the water, plus the depth the pile will penetrate the floor of the Gulf as a result of its own weight, determines the maximum length of pile which can be handled. If this limit is exceeded, the pile can be spliced after being partially driven.

Hard Driving Done in Conventional Manner

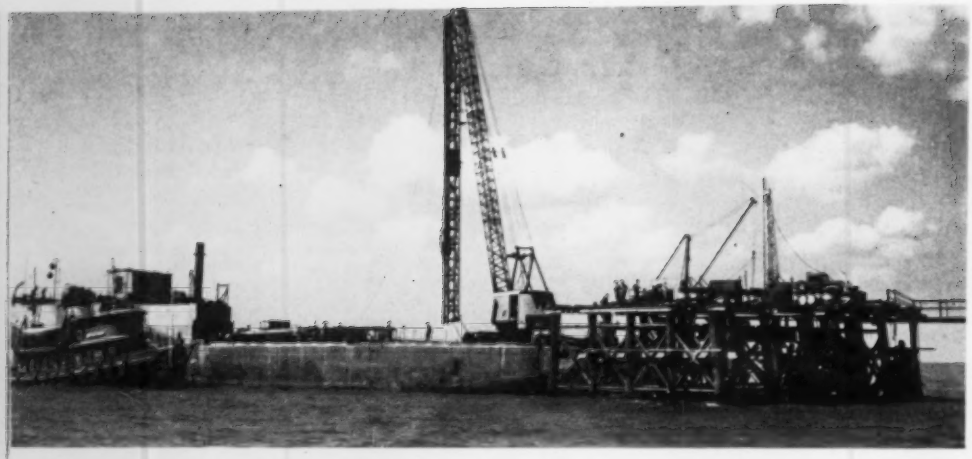
In this particular job, with the pile free on the bottom, the top of the pile extended some 30 ft above the top of the leads. The hammer, merely suspended from the crane boom, was placed on top of the pile and entered the leads as the pile was driven. The collar clamps around the pile were then swung clear, and the remaining hard driving was done in the conventional manner.

The hammer used on this job was a Vulcan, size OR, weighing 9 tons. Between hammer and pile a special helmet was placed, consisting of a 5-in. steel plate about 3 ft square which was positioned on the pile by means of a loose-fitting bull nose. A steel ring on top of the plate held a hardwood block which received the blow of the ram. Thus the striking energy was distributed over the full periphery of the pipe.

The pipes were driven with open ends. Resistance to driving at the beginning was the result of skin friction on both the outside and inside of the pipe. Later, as skin friction within the pile increased, some displacement and consolidation occurred in the soil below the tip of the pile as well as consolidation within the pipe itself. In some cases it was noticed that the ground level inside the pipe had been lowered as much as 10 ft. This lowering is advantageous if the structure is to be removed and it is desired to break the piles by blasting. The explosive charge may be placed inside the pipe below the floor of the Gulf without any prior removal of material from within the



CONSTRUCTION BARGE, which is converted Navy lighter, is not self-propelled but must be towed to construction site by tug. Tower at stern supports 60-ft open-top pile driving leads. Revolving crane directly in front of tower is shown loading piles. Crew quarters and radio room are in bow. Photo, Texas Industrial Film Co.



PIPE PILES for oil-drilling platform are driven off stern of construction barge. Small-type platform was built for Kerr-McGee Oil Industries by Brown & Root, Inc. Tug (left in photo) tows barge to construction site and carries each of barge's five anchors out 1,000 ft from ship.

pipe. The portion of the pile remaining after shooting will be below the mud line and will present no hazard to navigation.

Our experience regarding penetration in various locations may be summarized by stating that off the Texas coast and the adjoining Louisiana area, satisfactory bearing and sometimes refusal may be reached by penetrations of 40 to 90 ft, whereas to the east and increasing towards the Mississippi delta, penetrations of 150 ft and upwards are necessary. It is believed possible that off Galveston refusal might be experienced before the desired penetration because of the fact that one test pile was driven to refusal with only 38 ft of penetration. Then there is always the possibility that a location will fall on a thick shell reef. The question of penetration can only be answered by driving a test pile at the specific location.

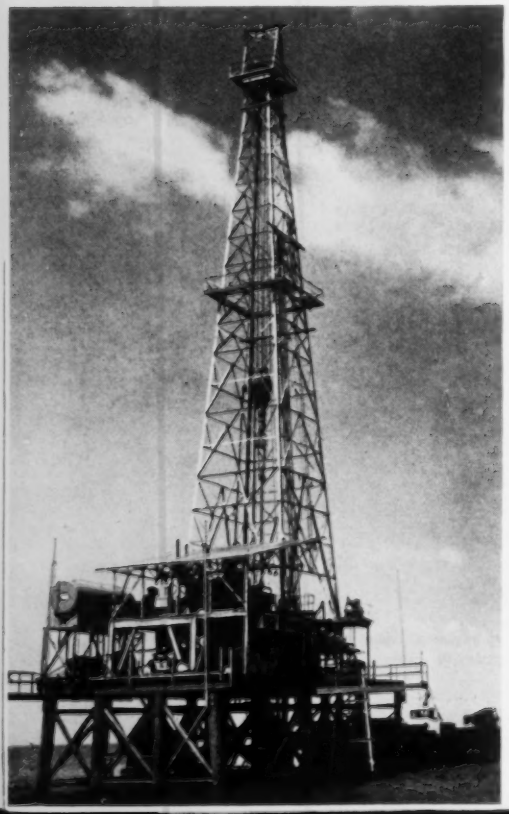
The under-water braces are $1\frac{1}{2}$-in.-dia galvanized prestressed bridge ropes. Prestressing to just under the elastic limit is done by the cable manufacturer and serves to remove the larger part of the structural stretch which would otherwise have to be taken out upon installation.

The simplest method of effecting an underwater connection between the pile and the cable is to fasten the cable to the pile before driving. In this work the connection between cable and pile was made before driving by wire-rope sockets pin-connected to a collar plate around the pile. Molten zinc connections between the sockets and the wire rope were used throughout. Cables are attached to the collar when the collar has cleared the bottom of the leads. No difficulty is experienced in handling the cables as the pile is driven to final depth.

Method Perfected by Experience

Considerable care and judgment must be exercised in determining just where to attach the collar to the pile prior to driving. The required penetration was known in advance from test-pile data which also furnished an indication of the firmness of the material immediately below the Gulf bottom. The ideal point of attachment was found to be below the mud line where the ground furnishes some side bearing on the pile to resist horizontal movement, but not to a depth that would prevent bringing the cable out on a straight line.

On one location it was necessary, because of bad weather, to leave a pile partly driven. When operations were resumed later, the pile was found to be "frozen" and could not be driven further, thus leaving the cable connection many feet above the point desired. In this case a new split collar was placed around the pile at the mud line and welded under water by divers.



COMPLETED SMALL-TYPE PLATFORM stands in 18 ft of water. Bitumastic compound covers all exposed parts of piles and extends well below water line. Platform was built for Kerr-McGee Oil Industries.

Upon completion of steel erection the cables were tightened, care being exercised to keep the piling plumb. A certain amount of initial tension was put in all cables, using a standard lever arm to rotate the turnbuckle.

Piles Aligned by Means of Timber Struts

After the piles were driven they had to be brought into alignment relative to one another. This was done by timber struts arranged in pairs clamped to the piles. Circular cuts in the struts at the proper spacing assisted in this operation. It was not difficult to move the tops of these piles the 1 or 2 in. sometimes necessary to bring them into exact position. The timber struts also served as a scaffold support for the subsequent work of cutting and capping the piles, welding trusses to caps, and making up the top connection of the cable bracing.

Transverse trusses were prefabricated in full 75-ft lengths while the intermediate longitudinal trusses came in 30-ft lengths. The trusses were welded to the pile caps and to each other at the points of intersection. Outside piles extended upward and were welded to both top and bottom chords. Interior piles were cut off lower and merely supported the bearing plate under the bottom chord. All horizontal truss connections were made by means of double welded lap joints which allowed about 2 in. of horizontal adjustment to provide for possible misalignment.

The setting of the trusses as well as the placing of the drilling equipment on the completed platform was handled by the crane on the work barge.

Piles were protected against corrosion by the application of the proper bitumastic compounds. This treatment covered the exposed portions of the piles and extended well below the water line. Structural steel received a similar treatment. The galvanized cables were protected by alternate applications of bitumastic and fiberglass tape.

The two-story living-quarters structure is 30×70 ft in plan. It was constructed and completely equipped in Houston, then transported by barge to the site. It was necessary to build the house in three sections

in order to bring the weight within the lifting capacity of the 50-ton crane on the work boat. Features of the structure include marine plywood inside and outside of walls, fiberglass insulation, aluminum windows and storm shutters, linoleum floors and a roof designed to permit the landing of a helicopter.

Work Done in Calm Sea

It may be a popular conception that during construction operations in the Gulf floating equipment is tossed about by waves while men try desperately to synchronize the task at hand with the roll and pitch of the craft. Such an idea could not be more erroneous. It is true that the Gulf is subject to squalls, southerly gales, "northers," hurricanes and so on, but a considerable proportion of fair weather remains which will permit construction operations.

The question naturally arises as to the work limitation imposed by the height of the waves. We have found that pile driving is not feasible in waves exceeding 4 ft in height, although the setting of steel and the handling of moderate loads can be carried on in 6-ft waves. Any heavy lifting or transference of large cumbersome units is done when the sea is calm.

A contractor working under a lump-sum agreement must include in his costs an allowance for standby expense when, although he is ready to work, he must await favorable weather conditions. Not infrequently it happens that after loading up, checking the weather and putting to sea he arrives at the location only to discover that some waves have developed in the meantime. He must then decide whether to come in or anchor at the site in the hope that the weather will change for the better.

CRAWLER CRANE and swinging leads construct small-type off-shore oil-drilling platform. Vulcan, 9-ton, OR hammer drives open-end pipe to piles penetration of 100 ft. Planking in foreground is deck of barge.

Among the members of the ASCE who may be classed as pioneers in their respective fields are C. Glenn Cappel of the W. Horace Williams Co., who has developed a unique type of platform, and Thomas F. Seale of the Kerr-McGee Oil Industries, the first operator to use the anchored drilling tender, thereby reducing platform size to a minimum.

Photographs in the article (except one credited to another source), and that on the cover, are courtesy of Elwood M. Payne, New York and Houston, Tex.

Oklahoma Pushes Plans for Protection of Its Valuable Surface Water Supplies

WATER—for irrigation and power, for domestic and commercial use—has a high value in Oklahoma, and the state is carrying out a carefully thought-out program for its conservation and for the protection of surface supplies against pollution, according to speakers appearing before the joint session of the Construction and Sanitary Engineering Divisions at ASCE's Spring Meeting in Oklahoma City. Four papers dealing with various aspects of this general theme were presented at this Thursday afternoon session, which was presided over by John H. O'Neill, Chairman, Executive Committee, Sanitary Engineering Division. "Construction Features of Fort Gibson Dam," a multipurpose project to store water for irrigation, power and supplemental water supply, was the subject of the paper presented by Col. C. H. Chorpening, M. ASCE, District Engineer, Corps of Engineers, Tulsa District. His paper appears elsewhere in this issue.

Merrill Chase—Mason Blanche Studios

John H. O'Neill, Chairman, Sanitary Engineering Division; Director, Division of Public Health Engineering, State Department of Health, New Orleans, La.

The session's second speaker, Carl E. Schwob, Chief, Division of Water Pollution Control, U.S. Public

Health Service, discussed "The Federal Water Pollution Control Program." The third speaker, E. W. Hamburg, Pollution Superintendent, Division of Water Resources, Oklahoma Planning and Resources Board, spoke on the "Protection of Natural Resources Through Planned Disposal of Oilfield Wastes," with special reference to the protection of Oklahoma's streams against this type of pollution. The fourth speaker was Webster L. Benham, Director, ASCE, and Consulting Engineer of Oklahoma City, whose discussion of Oklahoma City sewage treatment plants appears elsewhere in this issue.

Efficient equipment and methods for the oil industry received the attention of the Construction Division session held on Thursday morning, at which three papers were read. Ross White, a member of the Division's Executive Committee, presided. The authors were: M. P. Anderson, Assoc. M. ASCE, Chief Engineer, Brown & Root, Inc., Houston, Tex., whose subject, "Construction of Offshore Drilling Platforms with Large-Diameter Pipe Piling," is the basis for an article elsewhere in this issue; T. A. Hester, President, Oklahoma Contracting Co., Dallas, Tex., whose paper on "Pipeline Construction" is also printed in this issue; and Paul Hall, Assoc. M. ASCE, Chief Engineer, Fish Engineering Corp., Houston, Tex., whose paper on "Construction of a Gasoline Recycling Plant" detailed modern methods of utilizing the industry's by-products at a profit.

E. W. Hamburg

In the state of Oklahoma over a million people, or more than half the population of the state, are dependent on surface water supplies for their drinking and other domestic water, Mr. Hamburg stated. The streams, lakes and ponds are thus an important part of the state's natural resources and their protection against pollution is a major problem. He then explained what the Oklahoma Planning and Resources Board is doing about the problem. Control of stream pollution in the state was vested in this Board by a state law passed in 1941.

"Oilfield wastes have proved to be the most serious pollution problem with which this department has to deal," Mr. Hamburg said. "This has been especially true in the eastern half of the state, where an extensive oil-producing program has been in progress for the past 35 years—one of the larger producing areas in the world." Because of their concentration of mineral salts, the oilfield brines create a serious pollution problem and because of

Ross White, Member, Executive Committee, Construction Div.; Vice-President, Brown & Root, Inc., Houston, Tex.

the discharge of these brines many of the streams have lost their usefulness as sources of domestic or commercial water, he said.

In some areas, he stated, surface sands have been affected as much as a mile away from the stream carrying the brine, so that well water has been contaminated and pecan groves, orchards, alfalfa and other deep-rooted crops have suffered. He listed five methods of disposing of oilfield brines which the Division of Water Resources of the Oklahoma Planning and Resources Board has investigated since its establishment in 1937: (1) Solar evaporation in pits, (2) evaporation by artificial heat, (3) continual discharge into a stream, (4) storage and controlled discharge into a stream during flood periods, and (5) pumping into a subsurface salt-bearing formation.

As a result of this experience, Mr. Hamburg concluded that "disposal of brine by injection into a subsurface salt-bearing formation is the only method which will offer a positive solution to the brine-disposal problem in Oklahoma. We now have a great number of brine disposal wells and it is estimated that approximately 200,000 barrels of brine are being returned to salt-bearing formations per day in this state."

Successful subsurface brine disposal systems, he said, demand close supervision and proper maintenance. Injection of brine into a subsurface formation requires a well, usually pumping facilities, and generally pretreatment, which represents an appreciable investment, but the cost can easily be justified, he believes, by the need for abating stream pollution and the desirability of avoiding costly damage suits.

He listed precautions which the Division of Water Resources believes must be followed in oilfield development and production if the fresh waters of the state are to be protected from pollution. His list included provisions governing adequate capacity of slush and reserve pits; prevention of oil overflow from pits; blocking off of flows from wells out of control; prompt repair of leaks in pumps, lines, tanks, etc.; pumping out of oil sumps; provision of adequate firewalls; provision of satisfactory burn pits; use of solar evaporation only as a temporary necessity; construction of brine lagoons or pits, if used, so as to prevent seepage or introduction of surface drainage. Disposal of brine by controlled dilution has practically no application in Oklahoma, the speaker said, largely because of the uncertainty of rain periods and the impossibility of constructing seepproof impounding ponds.

Paul Hall

Before natural gas is pumped through pipelines for use as industrial and domestic fuel, its volatile gasoline content is removed in gasoline plants. Development of modern gasoline plants has resulted in the creation of a new petro-chemical industry permitting utilization of formerly wasted petroleum by-products at a profit, Mr. Hall stated in his paper. Natural gas, he pointed out, no longer is wantonly wasted, and new commercial uses have been developed for other oilfield "tailings."

"The availability of some of the lighter hydrocarbon components in quantity at reasonable cost," he stated, "has led to the development of new and valuable industries on the American scene." He also indicated that expensive methods for gathering gas and distillates now appear economically warranted. The oil operator today, he asserted, "is able to dispose of his by-product at a profit, create a new branch of the oil industry and, by making available new products, help foster a new and growing petro-chemical industry. The modern gasoline plant is the vehicle by which this beneficial result has been obtained."

Aerial Photogrammetry Locates Oil Wells with Pin-Point Accuracy

RALPH J. McMAHON
Magnolia Petroleum Co., Dallas, Tex.

MAPPING NEEDS of the oil industry have pyramided since the first oil company was formed in 1859. Today, when 34,000 companies are producing upwards of two billion barrels a year, the value of oil properties and potential oil properties demands accurate and efficient mapping techniques, such as modern aerial methods provide. Many maps require cautious search and observation to retrace the work of early surveyors. In fact the surveyor must know a good deal about the early history of the area as well as about early surveying and mapping techniques. Mr. McMahon's paper was presented before the Surveying and Mapping Division at the Society's Spring Meeting in Oklahoma City.

AERIAL PHOTOGRAMMETRY has revolutionized the oil map business. In the past fifteen years, the oil industry has settled down and is now operated on a more businesslike and scientific basis. The old boom days are over. Today, cadastral maps are being made from aerial pictures. The surveys are being tied to ground control and are plotted on the map using control and projections—thus giving the map more accuracy and detail.

Aerial photography was introduced to the oil industry about fifteen years ago. Since that time aerial pictures have been valuable in building accurate ownership maps which are being used by the geological, geophysical, engineering, land, pipeline and legal departments. Grid mosaics, which have been developed with accuracy, have aided the cartographer greatly, because the aerial map has brought into his office a section of the country. Such features as roads, railroads, rivers, creeks, towns and surveys are valuable information to the map compiler. In a sectionized state, the aerial mosaic is a great benefit because it makes visible roads and other features along the section lines.

In the past few years, the U. S. Coast and Geodetic Survey has worked out the Lambert Coordinate System whereby surveying and mapping can be performed in the field and plotted on the map with a higher degree of accuracy. The land surveyor who ties his work into stations of the national triangulation net, and defines the position of his land corners by giving their plane coordinates on the state zone system, provides evidence for the accurate restoration of these corners should they ever be destroyed. This Lambert Grid System was utilized by several oil companies in their operations in the Gulf of Mexico off the coast of Louisiana. In one map developed on the Lambert System, in the south zone of Louisiana, all tracts were laid out on a grid pattern showing 5,000 acres to each one. (See illustration.) Pinpoint accuracy has been accomplished in locating salt domes as well as wells.

What the Cartographer Must Know

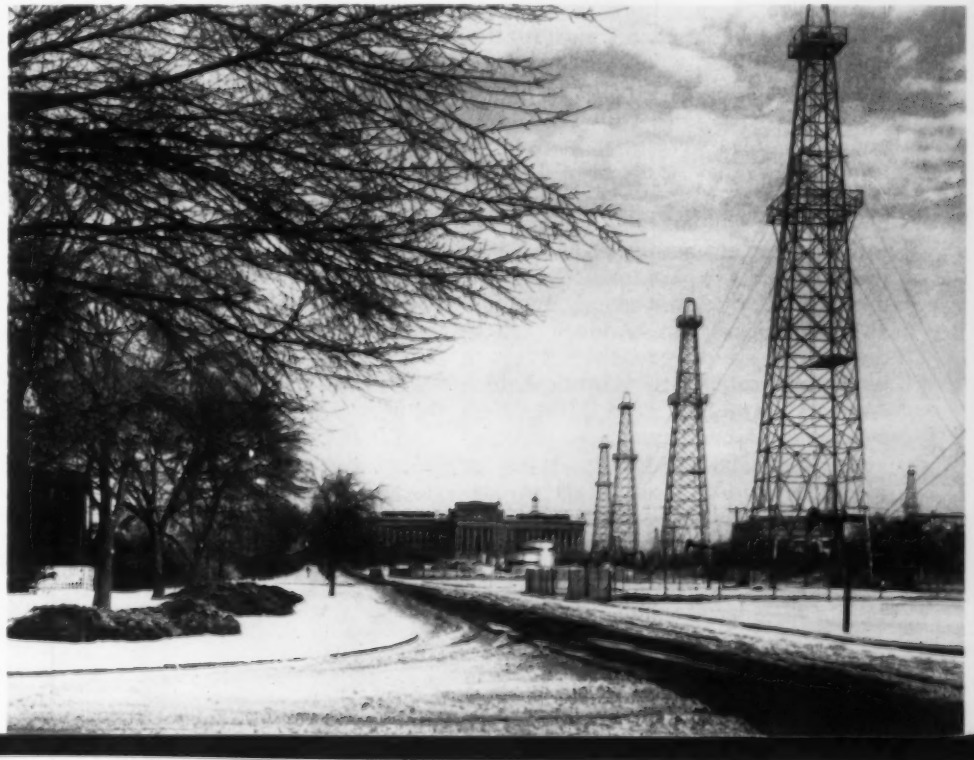
The cartographer who develops a cadastral map for the oil industry should have a wide variety of knowledge. He should know:

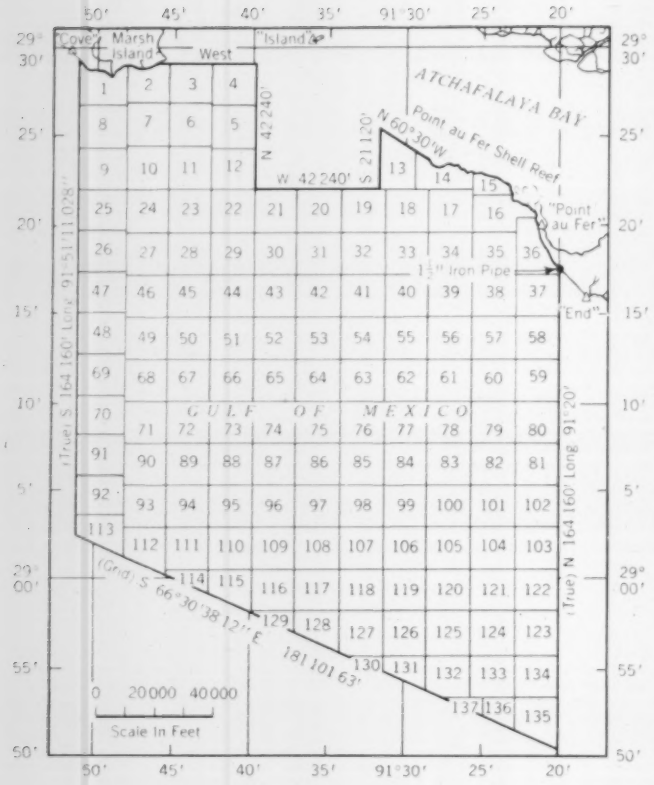
1. The fundamentals of land surveying.
2. Something about abstracting and record searching.
3. All the necessary symbols.
4. Map projection layouts.
5. The history of the country.
6. Techniques of map reproduction.
7. Something about the limitation of titles.
8. The many land measurements formerly used such as the vara, the arpent, the chain, etc.
9. How to calculate latitude and longitude.
10. Above all, he should have patience, good eyes and a strong constitution.

As mentioned in item (5), the cartographer who develops a map for the oil industry must know something about the history of the area, especially as it relates to that of the oil industry.

The oil industry began with the first producer at Titusville, Pa., in 1859, known as the "Drake" well. Even at that time, there were many uses for oil. Whale oil and other animal and vegetable oils did not meet the demand, and "natural" oil opened a great new source of lubricants, fuels and illuminating oil. Oil sold for as high as $20 a barrel. Men rushed into the industry as fast as they could raise the money to buy a "string of tools." In the next four years, these pioneers were producing oil at the rate of 3,000,000 bbl a year.

OIL INDUSTRY NEEDS accurate and comprehensive maps, especially in built-up areas. Even on grounds of Oklahoma State Capitol in Oklahoma City, closely spaced wells bear witness to importance of oil industry.





MAP ISSUED by Louisiana's State Mineral Board for lease of oil, gas and other rights offshore in Gulf of Mexico shows numbered blocks, each containing approximately 5,000 acres. All blocks are based on Louisiana (Lambert) coordinate system and survey begins at 1½-in. Iron Pipe at upper right. Base map was made from U.S. Coast and Geodetic Survey charts No. 1276 and 1277. Original of this plat, known as Eugene Island Area, is on file in State Land Office and Department of Public Works Office in Baton Rouge, La.

Oil was discovered in Texas near Corsicana in 1896. Prospectors for "black gold" were on the move; wildcats began to spring up all over the oil-bearing states of Kansas, Oklahoma, Texas and Louisiana. In those days, practically all prospective wells were "wildcats." Many significant oil fields have been discovered in the Southwest, the greatest of which was the East Texas field near Gladewater, which now has about 35,000 producing wells.

Today, the American oil industry produces more than two billion barrels per year. The first oil company of 1859, the Pennsylvania Rock Oil Co., has given way to some 34,000 progressive, competitive companies.

The discovery of oil meant the possibility that a property owner might become wealthy overnight. With the increased value of land, boundary lines were of more importance than they had been before. As land began to be leased for possible oil development, the demand for cadastral or ownership maps greatly increased. Map companies sprang up in nearby oil towns. Individual oil companies began to develop their own ownership maps. Surveyors were sent out into a prospective territory to obtain map information by running a compass-stadia traverse along roads, streams, etc., tying in all fences and later filling in the ownership tracts.

Cadastral maps for the oil industry are based on two separate and distinct land systems in the United States. The first is the rectangular system under the supervision of the U. S. Land Office in Washington, and the second is the metes and bounds system as used in the state of Texas under the supervision of the Commissioner of the General Land Office in Austin.

The system of rectangular surveys was first authorized in 1785 by an ordinance of the Continental Congress. It was an original system for the disposal of large parcels of land to the settlers of the new country. This plan provided a simple system of surveys, descriptions and identification for the public domain. Townships, each six miles square, were laid out in an east-and-west direction from a principal meridian, and in a north-and-south direction from some standard parallel or base line (Fig. 1). Each township contained 36 sections theoretically of one mile square, or as nearly so as possible, with the errors thrown in the north and west tiers of sections. The sections were divided into half, quarter or quarter-quarter sections. Sections were numbered from 1 in the northeast corner, in successive order in a zigzag pattern, to number 36, the last section in the southeast corner (Fig. 2). The government aimed to lay out the land by measuring distances and bearings and monument corners so that settlers could locate the tracts with reasonable accuracy for purposes of occupancy.

Since the earth is not flat, correction meridians were established every 24 miles to allow for convergence. The early surveyors or contractors did not have the precise instruments we have today; therefore some of their corners were not set as exactly as their plats might indicate. In retracing the lines run by these early surveyors, cautious search and observation are necessary.

Now, with the discovery of oil in a sectionized state such as Oklahoma, the making of cadastral maps was based on certain requirements. Take for example an ownership map made in Oklahoma City. By writing to the U. S. Land Office, the map maker can obtain a township plat indicating the surveys made in 1872 and 1873. Thus the plat of Township 12 North and three West shows the 36 sections, the acreage in each section, the variation the surveyor used, and the length in chains of each section. The Chisholm Cattle Trail, the Deep Fork of the Canadian River and the North Fork of the Canadian River are also shown. The correction surveys are shown in the upper quarter sections and the western quarter sections of the township. Offset corrections are shown along the base line of the township.

The township plat is not only valuable to the oil surveyor in the field, but also to the oil-map cartographer. Plats indicating the ownership of the various tracts are usually purchased from abstract companies. The early maps were laid out usually on a scale of 1 in. = 2 miles. More recent maps may be to a scale of 1 in. = 1,600 ft. The early maps disregarded any projections based on ground control; therefore the scale was not too reliable.

The other system used for cadastral maps for the oil industry was based on surveys by metes and bounds. Some engineers call these surveys "leaps and bounds" because of their uncertainties.

In Texas, land titles began with Spain, Mexico, the Republic of Texas and the state itself. Texas has its own public domain with all the original land records on file in the General Land Office in Austin. Land Districts were set up all over the state. Land Office maps were plotted from field notes and sketches sent in from the various land districts. Some of the early surveyors, such as Horatio Chrisman, who surveyed for Stephen F. Austin's colonies, did very good work. The map maker in the Land Office was confronted with the problem of interpreting the surveyor's field notes, for his maps were no better than the notes the surveyors sent in.

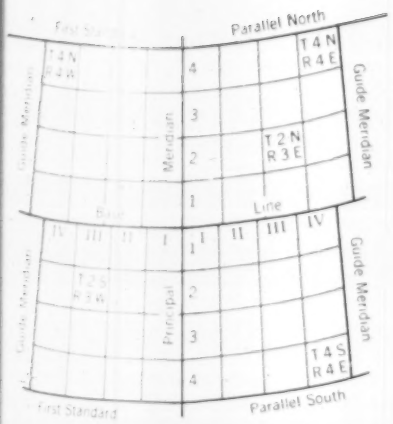


FIG. 1. RECTANGULAR SYSTEM of land division forms basis for cadastral maps for oil industry in land-grant states. Townships, each six miles square, were laid out in east-and-west direction from principal meridian and in north-and-south direction from some standard parallel or base line, according to system of rectangular surveys authorized for public lands by Continental Congress in 1785. Errors were thrown into north and west tiers.

The early surveyor had many problems. The peep-sight compass with a Jacob's staff and a Gunter's chain constituted the greater part of his equipment. His beginning corner was established by a stake which was referenced by two or three bearing trees with an "X" and hacks above and below. Sometimes a mound of earth was raised around the stake. The direction of the lines was obtained by means of a magnetic needle in a compass box. With these "tools" the early surveyors compiled the "notes" from which were born the early sketches and which were later assembled to form the first General Land Office maps.

Some Typical Early Maps

The basis of most oil maps in Texas was the Land Office County map, which was made on a scale of 2,000 or 4,000 varas to the inch. For instance, the Land Office map of Jackson County was plotted on a scale of 2,000 varas to the inch. (The vara is the legal land measurement in Texas and is $33\frac{1}{3}$ in. in length.) On this map, there is no projection and there are no control points; therefore there could be no over-all correct scale. This map is simply an index of all the surveys in the county plotted in their relative positions to scale from the original field notes. Along the Lavaca River, most of the surveys were Titled Grants dating from 1824 to 1833. Other surveys shown are first, second and third-class surveys, Donation, Railroad Script, Presumption and Bounty surveys.

One of the early grants, the Ramon Musquiz Grant, is bounded on the south by the Lavaca Bay, on the east by the Lavaca River, on the west by the Arroyo Venado and the Garcia Grant, and on the north by the Linn first-class survey. Ramon Musquiz received this grant of $5\frac{1}{2}$ sitios, or 24,354 acres, from Martin deLeon, Empresario of Mexico in 1833. An abstractor's plat for this grant and the adjoining property can be obtained from the county office.

An abstractor can obtain title information in each county in the state. A typical ownership map of Jackson County was compiled from

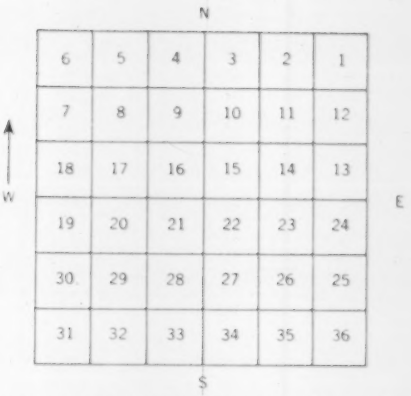


FIG. 2. OLD TOWNSHIP plats provide valuable data for use of oil surveyors. Each township in land-grant states was laid out in 36 sections, numbered successively from northeast to southeast corner in zigzag pattern

the Land Office base map and the abstractor's plats previously mentioned. Most of the early oil company maps were platted from tax and deed records. Since there was such a great demand for cadastral oil maps, time did not permit the oil company surveyor to control an area. His problem was to retrace the old surveys and their subdivisions. Of course, in a "hot territory," the surveyor was called on to make a more detailed survey of the property, which was used in developing the cadastral oil map.

Most of the major oil companies have maps mounted on rollers, called wall maps. These usually have a scale of 1 in. = 2,000 ft, or 2,640 ft. Special large-scale maps of important areas that demand more accuracy or detail are made on a scale of 1 in. = 800 ft, or 1,000 ft, or 1,600 ft.

United States Needs

Large-Scale Mapping Program to Meet Postwar Demands

ONLY HALF of the area of the United States has been mapped to date and only one-quarter by adequate up-to-date methods. In Oklahoma only 10 percent of the area is adequately mapped. These statements were made in the paper by E. W. Carlton, M. ASCE, Professor of Civil Engineering, Missouri School of Mines and Metallurgy, Rolla, Mo., presented before the Surveying and Mapping Division. The session was presided over by George D. Whitmore, chairman of the Division's Executive Committee. At the same session Ralph J. McMahon, Magnolia Petroleum Co., Dallas, Tex., discussed "Cadastral Maps for the Oil Industry—Requirements and Methods" (See article on preceding pages of this issue).

The third paper presented before the Division session described a vehicle-mounted device which indicates differences of elevation along a traverse. The authors are Dr. Daniel Silverman, Exploration Research Supervisor, J. D. Eisler and J. F. Evans, all with the Stanolind Oil and Gas Co., Tulsa, Okla.

E. W. Carlton

"The war emergency is now over and as we pause and evaluate our domestic mapping situation, the picture is not particularly encouraging," Mr. Carlton stated in his paper.

"The nationwide postwar public works program, industrial expansion, highway construction, mineral and natural resources investigations demand topographic maps in large quantities and in general on large scales. This demand has prompted the U.S. Geological Survey to review the status of the whole mapping program. Evaluation of all existing maps is being made, and areas covered by the more obsolete maps, based on inadequate control, are

being catalogued for remapping by photogrammetric methods. Maps with strong bases are being listed for revision and unmapped areas are being studied to establish a priority for mapping according to foreseeable needs. To meet this situation and at the same time satisfy the high priority map requirements of the War Department for national defense, the Geological Survey has proposed a 20-year mapping program.

"Methods of extending triangulation have been materially improved in the last 25 to 30 years. By the use of demountable steel towers, motor trucks, more accurate instruments and other modern equipment it is possible to average a station per day for each observer in a triangulation party during the working season. Contrasted with older work, triangulation parties now strive for moderately short lines (about 10 miles), and for location of stations as near highways as possible so they will be of practical value to local engineers and surveyors. Azimuth marks are placed on all stations and must be intervisible with the station from the ground for local convenience.

"The national net of vertical-control surveys now comprises more than 270,000 miles, with over 250,000 bench marks. About 20 percent of this is first order and the rest second order. The present program of the U.S. Coast and Geodetic Survey contemplates a complete first-order level coverage net in which the spacing between the level lines is to be about 25 miles. These first-order lines will, in most parts of the country, be subdivided by second-order levels spaced about 6 miles apart. Thus, a high-grade vertical-control bench mark will be within 3 miles or less of any point in any survey located anywhere in the continental United States. The current topographic program is the largest in history. More than 300,000 square miles are scheduled for mapping at the present time, involving over 2,000 separate quadrangles."

Speaking of the problem in the Missouri Basin, Mr. Carlton said that this area illustrates "the constantly increasing need for larger-scale topographic maps for development programs." The present program of the U.S. Geological Survey in this area is intended to provide adequate maps for location and planning engineering works of all kinds.

"Only a very small part of the Missouri River Basin has been mapped to date," he stated. "In order to provide the maps needed now in this great development, the Bureau of Reclamation has requested the U.S. Geological Survey to map some 50,000 square miles of lands in the upper basin. For over half of this area the maps are to be published on $7\frac{1}{2}$-minute quadrangles, with a scale

George D. Whitmore, Chairman, Surveying and Mapping Division; U. S. Geological Survey, Washington, D. C.

of 1 : 24,000 and with a contour interval of 10 ft, except that 5-ft contours will be used in certain flat areas. The remaining areas will be published on 15-minute quadrangles with a scale of 1 : 62,500 and a contour interval of 20 ft, with 10-ft dashed contours shown in the flatter areas. The planimetric bases will be prepared from aerial photographs and the contours will be added by ground methods where the country is unusually level, while in the steeper areas and the sand-hill region they will be obtained from aerial photographs by means of multiplex projectors."

After stressing the great need for more maps, Mr. Carlton said that one might well wonder at "the apathy of the people as a whole in their reluctance to adequately support a national mapping program. The obvious answer is to find a way to enlist the enthusiastic support of the average non-technical citizen. Mapping agencies such as the U.S. Geological Survey, the Coast and Geodetic Survey and others can do much more along this line than they have done in the past. Engineers can help greatly in their respective communities by devoting a conscious effort to the dissemination of mapping information."

In concluding his address, Mr. Carlton gave some figures on costs. "A recent estimate of $400,000,000 was made as the cost of completing the topographic mapping of the United States and areas under its jurisdiction," he said. "If such a program were to be completed under the afore-mentioned 20-year plan, it would mean an appropriation of $20,000,000 of federal funds for mapping each year. These figures do not cover the cost of the topographic maps, aeronautical charts and hydrographic charts our government will need in areas outside of the United States. Also, the above estimate could easily change depending on the publication scales and contour intervals required now and in the future. Another three to five million dollars would be required annually for revision purposes, to keep the maps up to date." Thus, he said, our mapping problem is seen to be a tremendous one and an absolute necessity.

Daniel Silverman, J. D. Eisler, J. F. Evans

A vehicle-mounted electromechanical device which indicates differences of elevation between successive points along a traverse was described in the paper by Dr. Silverman and co-authors Eisler and Evans. The development of this automatic elevation surveying device, they stated, was undertaken by the Stanolind Oil and Gas Co. Research Laboratories to provide a faster and less expensive means for carrying out extensive routine surveying in connection with the company's geophysical operations.

The principle on which the instrument is designed is illustrated in Fig. 1, an adaptation of the authors' Fig. 1. Their paper explained that the vertical is determined by a pendulum mounted in the device in such a manner that its axis of rotation is transverse to the direction of motion of the vehicle, and the factor for the determination of the distance is obtained from one of the wheels of the vehicle.

The pendulum was described as being "in the form of a light disk of non-ferrous metal suspended by two horizontally disposed torsional fibers under tension. The disk is eccentrically supported and acts as a long-period pendulum. To filter out high-

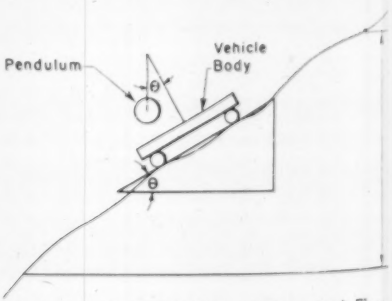


FIG. 1. OPERATION of Stanolind Elevation Meter follows principle of slope integration, whereby instantaneous slope of path traversed by vehicle is determined from angle (measured by pendulum) between the perpendicular to the vehicle body and the vertical.

frequency motor vibration and road shocks, the entire unit is mounted in the vehicle on rubber shock mounts. In order to minimize the effect of the angular instability of the usual vehicle, the authors explained that a survey is usually carried out in loops which are traversed in two directions. The forward and reverse runs around the loop are made consecutively, and the data obtained from the two runs are averaged out so as to cancel out long-term and persistent shifts in the attitude of the vehicle body.

"The instrument yields closure errors which are similar in nature to those obtained in surveying by standard methods and these errors are therefore amenable to distribution as a function of distance traversed," the paper continued. "Preferred use of the instrument is in closed loops and satisfactory data are obtained in continuous loops up to 20 miles in length, although shorter loops are preferable."

"Over a given one-mile stretch of road of moderate roughness," the authors declared, "the elevation meter, on repeated trials, will repeat itself with an average variation of about 0.3 ft from its own mean and with a maximum spread of values of about 1 ft." An error-frequency graph obtained from two days of testing on a line of level-established bench marks in Lincoln County, Kans., it was stated, fits roughly into a typical random-error frequency curve with a probable error of 0.4 ft.

A survey carried out by the U.S. Geological Survey in the course of its evaluation of the instrument, made north of Rolla, Mo., gave data which were compiled in such a way as to establish the effect of the length of the traverse on the precision of the survey. From the results the authors concluded that, "for relatively short loops, maximum expected errors would lie in the neighborhood of 1 1/2 ft, and median and average errors would be in the neighborhood of 1/2 ft. For larger loops, maximum errors of approximately 3.6 ft may occur, with average errors of less than a foot."

As to costs, the paper stated: "While no exact figures are available on the cost of surveys performed with the Stanolind Elevation Meter, unofficial estimates indicate that the cost per mile of survey with the meter is approximately $2.25 as against $7.00 per mile using standard surveying techniques. The reduction in survey cost per mile using the meter will vary with the type of terrain traversed, being the greatest in rough wooded terrain and least in a well sectionalized country having low topographical relief."

Surveys with this instrument, the authors declared, can be made by one man and may be carried out equally well in all types of weather and in daylight or after dark.

Experimental Research Urged to Improve Trunk and Pavement Design

WIDESPREAD failure of rigid and flexible pavements due to heavier and heavier truck loads shows the necessity for stricter enforcement of weight laws and more extensive research into better truck and pavement design. This topic was presented and freely discussed on the occasion of the Highway Division session at Oklahoma City, presided over by Hal G. Sours, chairman of the Division's Executive Committee. The two papers read were "Motor Vehicle Sizes and Weights," by H. S. Fairbank, Deputy Commissioner, Public Roads Administration, and "Effect of Heavy Loads on Pavement Design," by K. B. Woods, M. ASCE, Professor of Highway Engineering and Associate Director, Joint Highway Research Project, Purdue University.

K. B. Woods

Designs for highway pavements have been developed through extensive use of test roads; through use of theoretical procedures, many of which have been checked by field tests and observations; and by the combined experience of many highway engineers over a long period of time, Mr. Woods pointed out in his paper. Pavements designed and constructed on the basis of these many sources of information proved to be generally adequate for most sections of the country for the period 1920–1940.

Although information on the number and magnitude of loads which the highway systems carried through this period are somewhat meager, the data available, combined with general observation and experience, point to the fact that the repetition of exceptionally heavy loads and the number of axle loads above 18,000 lb were relatively small in most sections of the country. However, the speaker said, structural failure of rigid pavements and rutting of flexible pavements have occurred on large sections of the primary systems of many states during the past nine years—particularly in highly industrial regions or in areas where high concentrations of heavy loads occur. This widespread distress of pavements and the mass violation of existing truck-weight laws show rather definitely that the failures can be attributed almost entirely to overloads, or in some instances to exceptionally high concentrations of load at or near the legal axle-load limit.

Hal G. Sours, Chairman, Highway Division; Baldwin & Sours, Columbus, Ohio.

Mr. Woods drew the following conclusions: (1) That strict enforcement of weight laws should be pursued; (2) that the legal-load limits of most states should not be changed lest the existing highway systems of the country be destroyed by being subjected to loads in excess of those for which they were designed and constructed; and (3) that large-scale research on a national basis should be initiated immediately to determine the most economical design of both trucks and pavements.

In connection with pavement design, he added, available data indicate the need for several improvements, including: (1) Better means of compacting base-course materials for flexible pavements, and (2) additional experimental work to determine the economics and performance characteristics of rigid pavements, designed with subgrade deficiencies corrected by the use of base courses or some type of soil treatment, or by the use of thicker slabs with additional reinforcement.

Plastic Flow of Concrete Relieves High-Load Stress Concentrations

ROBERT F. BLANKS and DOUGLAS McHENRY, Members, ASCE

Respectively Chief, Research and Geology Division, and Head, Structural Research Section, Bureau of Reclamation, Denver, Colo.

STRESS CONCENTRATIONS around holes or openings in concrete structures or members have surprisingly little effect on the ultimate strength of the structure, according to recent tests on concrete blocks made at the Denver Laboratories of the Bureau of Reclamation. These tests indicate that a more complete understanding of the effects of such holes on strength and stability will lead to substantial savings in reinforcing steel. Analytical studies following the theory of elasticity, confirmed and extended by photoelastic tests, had previously indicated that important stress disturbances occur in elastic bodies in the vicinity of holes or openings. In the case of a plate containing a relatively small circular hole, for example, a uniform compressive load P applied to the two ends of the plate will produce a circumferential stress at the hole varying from compression equal to $3P$ to tension equal to P. Designers of structures, particularly concrete, are confronted with the problem of determining the extent to which such stress disturbances infringe upon the factor of safety, and they must specify the amount of reinforcing steel required to preserve this factor. At the meeting of the Structural Division in Oklahoma City, the recent tests at the Bureau of Reclamation's Denver Laboratories were described by Messrs. Blanks and McHenry in a paper which forms the basis of this article.

CONCRETE BEHAVES as a plastic rather than as an elastic material when it becomes highly stressed, as in the compression zone of a reinforced beam. The overstressed concrete near the extreme fiber does not fail when it reaches its so-called ultimate strength but yields plastically, transferring load to the understressed fibers nearer the neutral axis. It is reasonable to suppose that this same type of load transfer occurs in many other cases of compressive loading in which only a part of the structure or member is overstressed.

The nature of this load transfer may be demonstrated by a simple laboratory test. Imagine a cylinder of concrete surrounded by, but not in contact with, a concentric steel cylinder, the two being of exactly the same height. The steel cylinder will be provided with a strain gage for measuring its deformation in the axial direction, and it will be calibrated so that the amount of load it is carrying can be determined from the deformation measurements.

This assembly will then be placed in a testing machine and the steel and the concrete will be loaded together in compression. The strains in the steel and the concrete will of course be equal. The total load and the load carried by the steel will be measured, and the concrete load will be equal to the difference. From these measurements, the stress-strain diagram for the concrete can be drawn. Under this test condition, the concrete will not fail suddenly as it does in the standard compression test. As long as the concrete behaves elastically, it will carry a constant proportion of the total load; as it approaches its ultimate strength it will pass through a transition state in which a progressively greater proportion of the load will be transferred to the steel; and finally, as the total load is increased still further, the concrete will enter a plastic range in which it gradually loses load as it undergoes large strains without actually failing.

It is thought that this process of load transfer simulates closely the actual behavior of concrete in service when a member or a localized region is overstressed. In practice, it was found necessary to use a system of disk springs instead of the steel cylinder in order to accommodate the very large strains which developed in the concrete. It was also found that stress-strain curves which were nearly identical with those obtained by this testing system could be obtained without the use of the surrounding springs provided that the testing was done in a relatively rigid

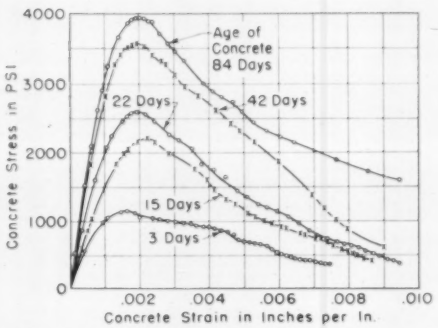


FIG. 1. STRESS-STRAIN CURVES show influence of age on 3×6-in. concrete cylinders under restraint of disk springs. Loading time for ages 42 and 84 days was 45 minutes; for other ages, 15 minutes.

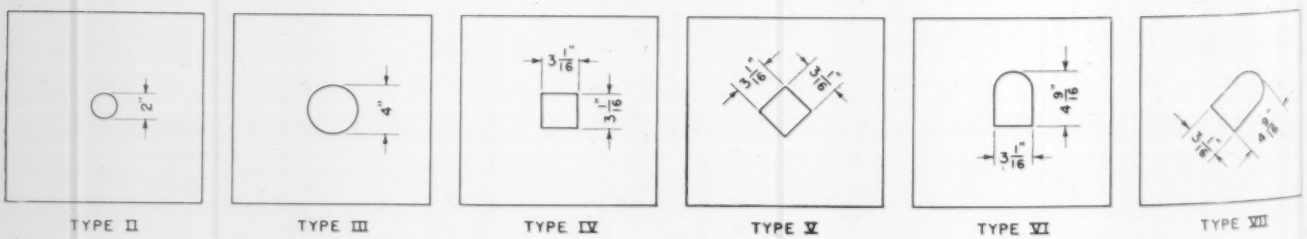
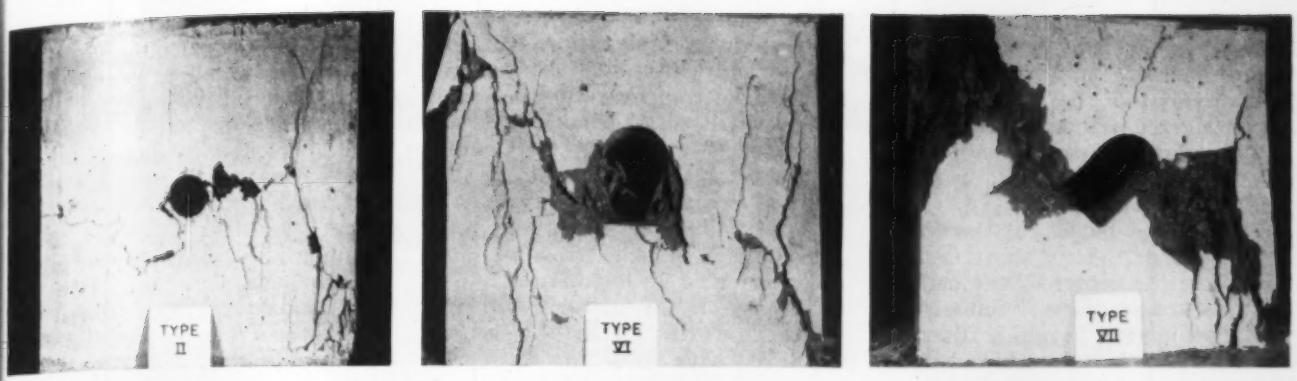


FIG. 2. CONCRETE BLOCKS with openings of various types sustain loads nearly as great as, or greater than, unpierced blocks. Type I (not shown) had no openings; other types tested had openings as illustrated. All blocks tested were 16 in. square and 8 in. thick.



APPEARANCE OF CONCRETE BLOCKS after compression test to failure indicates little or no need for reinforcement against compressive stress concentrations around openings. Type II, at left; Type VI, center; Type VII, at right.

testing machine so controlled that the strain energy which accumulated in the machine was released gradually rather than abruptly.

Typical stress-strain diagrams for concrete cylinders tested at ages ranging from 3 to 84 days are shown by Fig. 1. The limiting strain in concrete is often assumed for design purposes as 0.001 in. per in., but it will be noted that these tests show a substantial load-carrying capacity at strains up to eight or nine times that amount. The effect of long-sustained loads in the plastic range has not been thoroughly investigated.

In additional tests, one specimen which was kept under constant load in the plastic range for 5 hours lost load at a continually diminishing rate for $2^1/_2$ hours, and then appeared to reach an equilibrium condition in which it was supporting 60 percent of the maximum load with no further change. Other specimens which had been loaded until they entered the plastic range were removed from the testing machine and placed in sustained loading rigs under loads of 50 to 75 percent of the maximum testing machine loads. All the specimens which were loaded to more than 63 percent of the maximum load failed within one day; two specimens loaded at 60 percent failed after one month; one specimen at 60 percent was still carrying that load after one year; and one specimen under a load of 50 percent of the maximum for 85 days increased in strength, as shown by a second higher ultimate when tested to failure.

After obtaining this positive evidence of the plastic behavior of concrete under high loads, tests were made on a series of concrete blocks containing openings with the thought that such tests would evaluate in a qualitative way the effect of the plastic action in relieving stress concentrations at the openings. The tests turned out to be of greater quantitative significance than had been anticipated, for instead of indicating a more-or-less indeterminate stress relief due to plasticity, they appear to show that the stress concentrations were completely eliminated before the failing loads were reached.

In this test series, 26 concrete blocks 16 in. square by 8 in. thick, and 39 control cylinders 6 by 12 in., were tested to failure in compression. Eighteen of the blocks contained openings of various shapes as shown in Fig. 2, while 8 were cast solid for strength comparisons. Four specimens were cast of each of the Types II, III, and IV, with two specimens each of Types V, VI, and VII. Sixteen of the specimens were tested at the age of 28 days and 10 were tested at the age of one year. The concrete contained $^3/_4$-in. maximum aggregate; the water-cement ratio was 0.53; and the average slump was 3 in. The block types were randomized within batches.

The concrete was vibrated in the forms and placed in a fog atmosphere at 70 deg F immediately after casting. When the specimens were 24 hours old, they were removed from their forms and left in the fog room until they reached the designated testing ages of 28 days or one year. Preparation for testing included surface drying, capping of top and bottom with a mixture of sulfur and fire clay, and painting the surface to make the development of surface cracking more readily observable.

TABLE 1. RESULTS OF BLOCK TESTS SUMMARIZED

Batch and Specimen Designation	Block Type	Min. Section, Sq. In.	Ult. Load, Lb.	Avg. Stress on Min. Section at Failure, psi	% of Solid Block Unit Strength of Same Batch	Load at Initial Observed Cracking, Lb	Avg. Stress on Min. Section at Initial Crack, psi	% of Ult. Loads at Initial Cracking
For Blocks Tested at Age of 28 days								
A	I	128.0	421,000	3,290	100.0	380,000	2,970	90.3
B	I	128.0	424,000	3,310	100.0	380,000	2,970	89.6
C	I	128.0	440,000	3,440	100.0	414,000	3,230	94.1
D	I	128.0	442,000	3,450	100.0	360,000	2,810	81.4
B	II	112.0	366,000	3,270	98.8	200,000	1,790	54.6
D	II	112.0	358,000	3,200	92.8	288,000	2,570	80.4
A	III	96.0	328,000	3,420	104.0	100,000	1,040	30.5
C	III	96.0	340,000	3,540	102.9	258,000	2,690	75.9
A	IV	103.5	360,000	3,480	105.8	120,000	1,160	33.3
C	IV	103.5	388,000	3,750	109.0	300,000	2,900	77.3
B	V	93.36	323,000	3,460	104.5	196,000	2,100	60.7
D	V	93.36	336,000	3,600	104.3	280,000	3,000	83.3
A	VI	103.5	333,000	3,220	97.8	158,000	1,530	47.4
B	VI	103.5	332,000	3,210	96.8	248,000	2,400	74.7
C	VII	89.76	326,000	3,630	105.5	164,000	1,830	50.3
D	VII	89.76	315,000	3,510	101.7	236,000	2,630	74.9
For Blocks Tested at Age of One Year								
E	I	128.0	746,000	5,830	100.0	240,000	1,880	32.2
F	I	128.0	794,000	6,200	...	260,000	2,030	32.7
G	I	128.0	800,000	6,250	...	220,000	1,720	27.5
E	II	112.0	826,000	6,450	100.0	190,000	1,480	23.0
F	II	112.0	694,000	6,200	106.3	100,000	890	14.4
G	II	112.0	714,000	6,380	102.5	92,000	820	12.9
E	III	96.0	652,000	6,790	116.5	68,000	710	10.4
F	III	96.0	668,000	6,960	111.8	62,000	650	9.3
E	IV	103.5	668,000	6,450	110.7	60,000	580	8.9
G	IV	103.5	682,000	6,590	102.1	68,000	660	10.0

Blocks were centered under the head of a 4,000,000-lb compression testing machine and two or more observers noted the appearance of cracks which developed during application of load. Load was applied to the specimen at a rate of about 1,000 psi per minute.

On the solid blocks, first cracking was observed to be a short vertical crack near the center of one or both of the square faces. Subsequent cracking in a diagonal direction usually determined the ultimate directions of shear failure. Initial cracking in blocks with openings appeared as vertical cracks just above or below the opening. This initial cracking extended under increasing loads until cracks several inches long were attained above and below the opening. However, these central vertical cracks never became very prominent, and some of them closed completely as the loading progressed. Under higher loads, cracks appeared at the sides of the holes, and diagonal cracks appeared which developed into planes of shear failure. Minor horizontal or vertical cracking was frequently observed at loads about half the maximum, with cracks commonly ending in a corner of a square opening or tangent to a circular opening.

Photographs of the crack patterns were taken after the ultimate load had been reached and again after the blocks had been further crushed down. Typical appearance of three types of blocks can be seen in the illustrations. The companion control cylinders were tested to determine modulus of elasticity, Poisson's ratio, and ultimate compressive strength for comparison purposes.

The results of the block tests are summarized in Table 1. Column 5 shows, for the various blocks, the average compressive stress at the time of failure—that is, the total load divided by the cross-sectional area, corrected for loss of area due to openings. In Col. 6 these ultimate stresses for the pierced blocks are compared with those for the corresponding solid blocks. It will be noted that the load-carrying capacity is very closely proportional to the net area and that there is no significant loss in strength due to the theoretical stress concentrations. In fact, the average strength of the pierced blocks is 4 percent higher than that of the solid blocks. If the areas are compared for 45-deg planes instead of for the minimum sections, thus coming somewhat closer to the actual failure surfaces, the strength comparison will be changed slightly and the pierced blocks will average 2 percent lower in strength than the solid blocks. In either case, however, we can say that the strengths are the same within the limits of experimental uncertainty.

Columns 7, 8, and 9, which show the loads and average stresses sustained at the time of initial cracking, reveal some interesting data. In the tests at the age of 28 days, the solid blocks cracked at loads of 81 to 94 percent of the ultimate, and the pierced blocks cracked at loads of 33 to 80 percent of the ultimate. However, at the age of one year the range for the solid blocks was 23 to 33 percent, and for the pierced blocks it was 9 to 14 percent. It will be noted, too, that although the one-year blocks were much stronger than the 28-day blocks, the older specimens cracked at much lower loads, in the case of both the pierced and the solid blocks. This behavior suggests that the younger concrete has a marked ability to adjust itself to tensile as well as compressive stresses, while in the older concrete the tensile adjustment is much less marked.

These tests were designed to contribute toward the solution of the problem: To what extent do the stress disturbances at openings infringe upon the factors of safety, and how should such openings be reinforced to preserve these factors? From a simple review of the test data, with no attempt to analyze the problem in detail, it appears that when loading conditions are similar to those of the tests, reinforcement for compressive stress concentrations can be omitted around openings without thereby reducing the ultimate strength. More and more information is accumulating in support of the ultimate design theories, and it seems that designers should view these theories with at least an open mind so that advantage may be taken of whatever they have to offer in the way of more rational design methods and savings in construction costs.

Structural Engineers Feature

Better Design Methods

A METHOD for the calculation of varying end restraints of compression members in rigid frames was presented by Harold E. Wessman, M. ASCE, Dean of Engineering, University of Washington, and Thomas C. Kavanagh, Assoc. M. ASCE, Department of Civil Engineering, Pennsylvania State College, in one of the three papers presented at the spring meeting of the Society's Structural Division. The other papers were: "Slope Deflection Equations for Curved Members," by Keith T. Fowler, Jun. ASCE, Structural Engineer, International Harvester Co., and "Plastic Action of Concrete at High Loads Relieves Stress Concentrations," by Robert F. Blanks, M. ASCE, and Douglas McHenry, M. ASCE, of the Bureau of Reclamation. An article based on the latter paper appears on the preceding pages. J. M. Garrelts, Secretary of the Structural Division's Executive Committee, presided over the session.

H. E. Wessman and T. C. Kavanagh

"One of the problems of current interest to structural engineers is the behavior of compression members which are parts of rigidly connected structural frames and are consequently subjected to varying end restraints." Mr. Wessman and Mr. Kavanagh have developed a method for calculating these end restraints, and the effective lengths of compression members under load conditions.

The procedure developed by the authors is "an extension of the Lundquist moment-distribution method for analyzing the stability of a structural frame." In conclusion they pointed out that "for compression members in steel trusses within the usual range of slenderness ratios the buckling

(*Continued on page 95*)

White Studio, New York

J. M. Garrelts, Secretary, Executive Committee, Structural Division; Associate Professor of Civil Engineering, Columbia University, New York, N. Y.

Supersonic Methods Short-Cut Reservoir Silt Measurements

CHARLES W. THOMAS, Assoc. M. ASCE
Engineer, U.S. Bureau of Reclamation, Denver, Colo.

THE ENTIRE ECONOMY of the semiarid western United States is dependent upon reservoirs for water storage. Silt-laden rivers carry sediment in amazing quantities—two billion tons have been deposited in Mead Lake behind Hoover Dam since 1935—and this sediment slowly but permanently impairs reservoir storage capacity. Studies of the location and extent of deposits, and the movement of silt-carrying density currents within them surely will extend the useful life of storage reservoirs. High-frequency echo-sounding equipment is standard for depth measurements, and several electronic instruments are being tried out for coordinating quickly the horizontal location of the soundings. After describing conventional silt-survey equipment and procedures before the Hydraulics Division session in Oklahoma City, Mr. Thomas challenged engineers to further develop supersonic sounding equipment to measure depths of silt directly as well to explore the behavior of density currents.

ECONOMIC LIFE of any water conservation or utilization project, whether for irrigation, flood control, navigation, power, domestic water supply, or other use, is directly dependent upon the length of time that the reservoir continues to fulfill the purpose for which it was built—namely, the storage of water. Reservoir sedimentation must be studied extensively in order to plan the proper location and operation of outlets through the dam and the reduction of sediment accumulation in the reservoir.

The Bureau of Reclamation has constructed approximately 80 storage reservoirs since its inception as a federal service. Operation of these reservoirs is complicated because they must serve multiple purposes by storing water for irrigation and power and making available additional capacity for flood control.

After construction of a dam, changes occur in the stream channel for a considerable distance both upstream and downstream from the structure. These changes are caused by the departure from virgin conditions in quantities of water released into the same channel, by a similar change in the sediment content of the water released, by changes of velocities, by a combination of these factors, or by deposition of silt in backwater areas. The results of these changes may be to increase drainage difficulties, increase the head on pumping plants, cause excessive scour around existing structures, cause excessive deposition around river developments, or produce other effects due to changes in stream regimen.

A study of the reservoir surveys conducted to date has made it possible to determine the location of the sediment deposits within the reservoirs. This determination is important from many standpoints, particularly with regard to planning aspects. It has been found that 60 per cent of the sediment in Guernsey Reservoir, Wyoming, is deposited in the upper 35 percent of the reservoir depth, calculated from spillway level. This reservoir is operated so that the reservoir pool is held nearly constant during the irrigation season. In Roosevelt Reservoir, Arizona, which operates over wide variations in pool elevation, only 30 percent of the sediment is deposited in the upper 35 percent of the depth. In contrast to these two reservoirs is the deposit in Elephant Butte Reservoir, New Mexico, where approximately 50 percent of the sediments are found in the upper 25 percent of the reservoir depth. This reservoir also has considerable variation in operating levels.

The most important conclusion to be drawn from these studies is that in all cases so far studied in the West, over 50 percent of the sediment deposits lie in the upper half of the reservoir. Inasmuch as allocations for sediment storage in reservoirs have normally been placed at the bottom of the reservoir, it seems advisable to question continuation of the practice of allowing relatively large amounts of dead storage that will not be filled with sediment for many years.

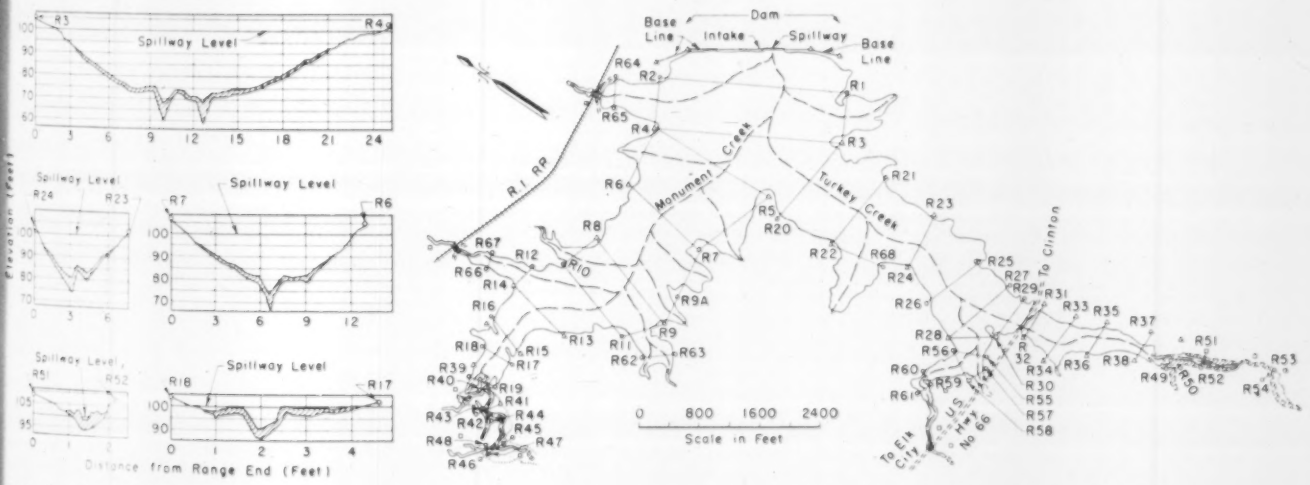


FIG. 1. SOUNDINGS, along range lines normal to reservoir axis, measure sediment deposits in Lake Clinton, Oklahoma. Silt range lines are tied together by triangulation system expanded from measured base-line on dam. Shaded areas on cross sections indicate extent and location of silting. Survey was made by Soil Conservation Service, U.S. Department of Agriculture.

MODERN SUPERSONIC ECHO EQUIPMENT used by Bureau of Reclamation for reservoir sediment surveys provides complete mobility, as reservoirs are widely separated geographically. Boat 18 ft long, with 52-hp inboard gasoline engine, has ample space for five-man crew. One set of oscillators for supersonic echo sounding equipment is permanently installed in hull and brackets provide for outboard mounting of separate pair of oscillators. Smaller boat, with outboard motor, obtains soundings in shallow water. Survey boat and trailer are towed from one reservoir to another by 1½-ton, four-wheel-drive Dodge power wagon equipped with racks and hitches.

Conversely, it has usually been considered that the upper levels of reservoirs, usually allocated to flood control in multipurpose projects, would be free from sediment deposits. Data so far collected show that in some cases this section of the reservoir may be subject to the greatest amount of sediment deposition. These facts should alter our planning of reservoirs, particularly those intended for multipurpose operation.

Surveys of sediment deposits in reservoirs must be adequately planned in order that they may furnish a maximum of information from which to calculate the length of time required for the sediment to accumulate to the extent of impairing operation or ending the useful life of the reservoir. The exact location of the sediment with regard to the dam thus becomes important.

For that portion of the survey lying above the water surface existing at the time, the survey procedure is similar to that followed in making ordinary topographic determinations. Some modification in methods and equipment used is necessary to penetrate shore-line vegetation and to negotiate the mud flats.

That portion of the reservoir below the existing water surface is not readily accessible. The usual procedure in this case is to employ hydrographic survey methods. Hydrographic surveys are three dimensional. A sounding represents a vertical dimension downward from the water surface to the bottom of the reservoir. This sounding must be located in the horizontal plane by two coordinates. Hence, in addition to the sounding, there must also be a horizontal control for the survey.

In large reservoirs, soundings are made along predetermined sedimentation "ranges" or reservoir cross-section lines. Where practicable, these ranges are located normal to the stream flow and the valley, and spaced so that the average end areas of adjacent ranges are representative of the section between them. Ranges are located across the mouths of all principal arms of the reservoir, and extend up these tributaries in a manner similar to that on the main stream. The ends of each range are permanently marked, and all ranges are tied together by an active triangulation network expanded from a chained and checked base-line. In small reservoirs these ranges may be spaced sufficiently close so that bottom contours can be drawn. In some reservoirs, when it is desired to develop bottom contours, ranges can be dispensed with and independent sounding surveys made.

One of the two major factors involved in a hydrographic survey is obtaining the soundings. These are made in shallow water by means of a sounding pole with a baseplate. The general practice for measuring greater depths has been, until the past few years, to make soundings by conventional lead-line methods, or by some mechanical device. A rope or lead line held in the hand, or a piano wire on a sounding wheel, have been used, and can still be used to advantage under certain circumstances. However, the more modern supersonic echo sounding equipment is now more generally utilized.

Horizontal control of reservoir sedimentation surveys utilizes two general classes of equipment: (1) Planimetric survey and navigation instruments, and (2) electronic equipment. The first method is now used almost exclusively, while the latter method has been used in coastal and land surveys and could be adapted to reservoirs. The possibility of using photogrammetry has been considered, but to date no practical application has been made.

When range lines are used, the problem resolves itself into locating the survey craft as it progresses along them. Coordinating position and depth determinations is facilitated by the fix-button, which is an integral part of the echo sounding equipment. Each time this button is depressed, a permanent mark is made on the sounding chart. These fix marks are identified by numbers. The craft is kept on the range line by the operator, who lines up objects on shore, or by a transitman stationed at one end of the range line, who signals the helmsman when deviations from course occur.

Conventional Survey Methods Slower

The following methods employing optical and mechanical equipment have been used successfully to accomplish the horizontal control, but are dependent upon visibility from shore to survey craft:

One or more transits are set up on shore, at suitably situated and accurately located triangulation stations, and the angles from known geographic locations to the survey craft are read at the instrument or instruments. The angle or angles are read periodically, and a voice, radio, or flag signal is transmitted to the survey craft at the exact instant when the measurement is made so that the fix can be recorded on the sounder chart. This method gives accurate results but necessitates trained instrumentmen and some means of boat-to-shore communication. Notes must be kept both on the craft and on shore and these must be coordinated frequently.

Another method of using intersection to determine the position of the survey craft on the range line is with alidade and plane table. One or more plane tables are located on shore at carefully located points, and the angle between a known point on shore and the survey craft is determined graphically. This method gives results slightly less accurate than the use of transits.

A method of resection is used to determine the position of the craft

on the range line by reading the angle between two points on shore with a sextant located on the survey craft. The monuments, or points on shore, must be accurately located. This is a simple, accurate method and does not necessitate communication between the boat and the shore except to keep the survey boat on the range line. Since the angles are read at or near the sounder, notes may be made directly on the recording. One man on the boat can operate a sextant with a small amount of training.

Piano wire on a calibrated reel is used to measure the distance from the boat to a known point on land as the boat proceeds along the range line across the reservoirs. This method, which requires only a calibrated reel for the wire, has the advantage of being used and read on the craft. The silt range monument and the shore anchor for the wire must be accurately located. The boat is kept on the silt range line by range markers or by instrumentmen. Floats attached to the wire at intervals keep it on the water surface and hence in a horizontal position. Distances up to one mile are measured in this manner without appreciable error.

A calibrated Price-type current meter is used to measure the distance along the range line. The meter is suspended in the water, and the revolutions of the bucket wheel are counted electrically as the boat proceeds. From data read on the calibration curves for the meter, the distance traveled is calculated.

Where it is desired to study the deposition of material brought in by tributaries and deposited as a delta, or to determine accurate bottom contours, a piano wire is fastened to an anchor on shore and the boat is moved in arcs about this point as a hub. Arcs of 25 or 50 ft in radius are ordinarily used. The location of the boat on the arc is determined by the transit or plane table.

There are a number of methods of horizontal control that employ electronic equipment. Some of this equipment has been used in making hydrographic surveys, and there is other equipment that may be applicable to hydrographic surveys or reservoir sedimentation surveys. A brief description of the equipment and method of operation of a few of these electronic devices follows:

The Shoran method was developed for precision control of air-borne aircraft on bombing missions during the war. Two land stations control a number of air-borne stations aboard the bombers. The Coast and Geodetic Survey has successfully used

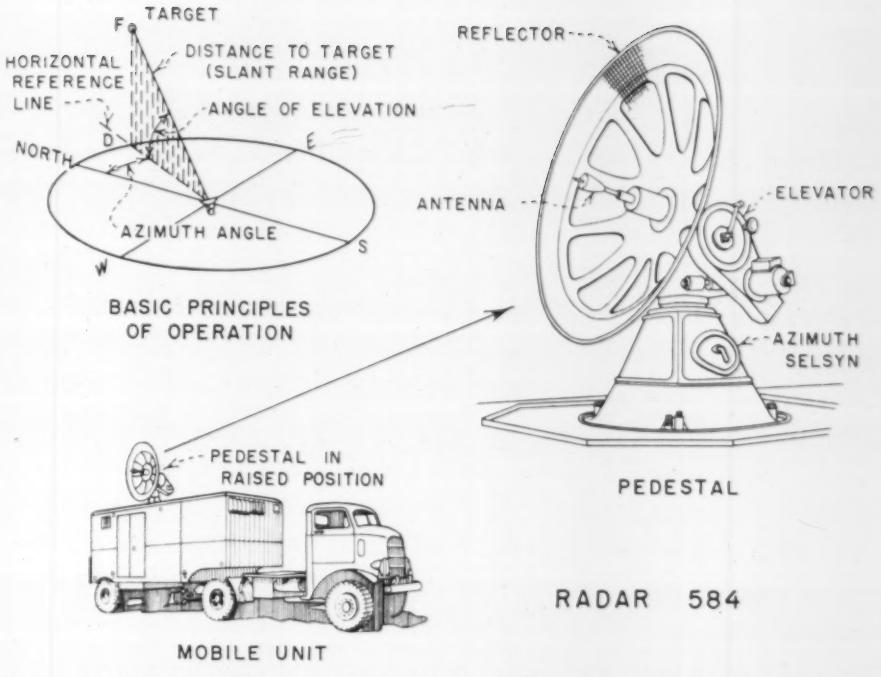


FIG. 2. RADAR EQUIPMENT, as adapted by Corps of Engineers for horizontal control of surveys in Galveston Harbor, consists of large truck-mounted steel van (mobile unit SCR-584) with all equipment and controls inside. Responder was mounted on survey craft to assist antenna in tracking survey boat. Both Shoran and SCR-584 operate on ultra-high frequencies and micro wave lengths and hence are line-of-sight instruments which are not operative over long distances or over rough or wooded terrain.

this equipment in conducting offshore surveys in both the Atlantic and the Pacific Oceans. Two accurately located shore stations and one station on the craft are needed. The station on the craft radiates pulses in alternate groups at two different carrier frequencies of very short wave length. One of the shore stations is tuned to one carrier frequency and the other station to the remaining frequency.

Reception of the pulse from the aircraft causes a ground station to act as a transponder and relay a pulse on a different frequency back to the craft, where it is received and displayed and the distance to the station recorded. The equipment consists of compact and well-built components, and the accuracy is good for long distances, but the percentage of error is greater for short distances. This is due to equipment errors. Estimated probable error with unmodified Shoran equipment is ±50 ft regardless of the distance.

The Corps of Engineers, Department of the Army, has experimented with the use of SCR-584 radar system in Galveston harbor. Soundings in this harbor had been located previously by two sextant angles read aboard the survey boat between prominent landmarks on the shore. An effort to speed up this method by a sextant angle grid was a definite improvement, but the fact that the work could be delayed by bad weather and poor visibility was another difficulty that had to be overcome. The mobile radar unit SCR-584 consists of a large truck-mounted steel van with all equipment and controls inside. The antenna, located on the roof of the van, will automatically position on a ship and track it. Readings for range and azimuth are obtained from dials. A small telescope mounted on the antenna may be used to assist in the initial orientation of the unit. A portable generator furnishes operating power.

For the Galveston surveys a responder was mounted on the survey craft to assist the antenna in tracking the survey boat. Ship-to-shore radio contact was maintained for supervision of the work. The results of the experiment showed that a greater error existed in the data from the measurement of the angle than from the distance measurement. Distance measurements were obtained with an error of ±6 ft for the best results.

A system known as Raydist, developed by the Hastings Instrument Co., Hampton, Va., for wartime use has since undergone intensive development as a means of surveying over water or rough terrain and as a precise navigation and tracking system. In these applications the Raydist system results in high accuracy with the use of light and simple apparatus. Raydist is a continuous wave system

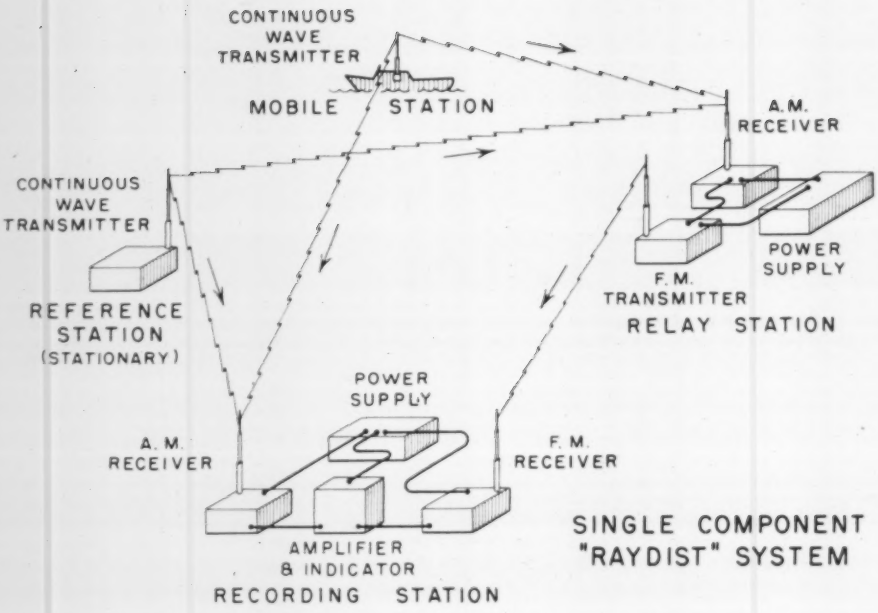


FIG. 3. RAYDIST SYSTEM, developed by Hastings Instrument Co., Hampton, Va., for wartime use, has since undergone intensive development as means of surveying over water or rough terrain, and as precise navigation and tracking system. System may be set up as hyperbolic line-of-position or pure range system to measure straight-line distance between portable unit and single fixed ground station. Accuracy is limited only by consistency of radio propagation phenomena. Method accomplishes equivalent of setting up standing radio waves in space and permits counting of number of waves set up in given distance.

and depends on the relative phase relationship between continuous wave radio transmitters.

Probably the best application of this equipment for sedimentation surveys is to use it as a pure range system. Only two instruments are required, and a continuous indication of the distance between the two sets is obtained. If one instrument were located at the end of the range line and a recording instrument carried in the survey craft, continuous indications of distance along the line could be had. Equipment of this type built for the Navy has been put in operation, and consistently repeated measurements within 2 ft on the indicators and 5 ft on the recorders have been obtained. These errors were obtained in distances of approximately 6 miles. The equipment may be completely housed in suitcase-type cabinets, the heaviest single unit weighing approximately 32 lb. Equipment necessary for the horizontal control of a sedimentation survey would probably cost in the neighborhood of $20,000 at present, but this amount should be reduced after exact needs are known and production of the equipment increases.

Lorac, or "long-range accuracy," developed by the Seismograph Service Corp., is another radio surveying system operating on medium frequencies and medium wave lengths. The use of medium frequencies and low voltages causes the equipment to be less susceptible to common electrical problems that give trouble in high-frequency, high-voltage systems and does not confine its use to line-of-sight operation. In this system three shore stations and one boat installation are required. The boat installation is quite small, and the major portion can be mounted in an out-of-the-way position.

The three land stations are bulky and presently used equipment is not easily moved. This characteristic would be a disadvantage in sedimentation surveys in that when the survey moves from one portion of a large lake to another, it would probably be necessary to move the shore equipment. The average repeatability error in distances up to $9^1/_2$ miles has been about $2^1/_2$ to 3 ft.

Equipment for Normal Silt-Survey Party

The equipment now employed by the Bureau of Reclamation is designed to provide complete mobility, since the reservoirs are separated geographically. This separation distance may be a few miles or several hundred miles. The prime mover consists of a $1^1/_2$-ton, 4-wheel-drive, Dodge power wagon equipped with racks and hitches for carrying the survey equipment and towing the survey boat and trailer. This vehicle has adequate power to traverse rough terrain and will develop satisfactory speed for moving from one lake to another without undue delay. A station wagon is also employed to carry instruments and personnel and to serve as a utility vehicle.

An 18-ft boat with a 6-ft 8-in. beam is used for the under-water survey. This craft is of the open type, has a plywood hull, and is powered by a 52-hp inboard gasoline engine. The boat has ample space for a five-man crew. One set of oscillators for the supersonic echo sounding equipment is permanently installed in the hull of the craft, and brackets are provided for outboard mounting of a separate pair of oscillators. A small boat with an outboard motor obtains soundings in shallow water.

A two-wheel trailer capable of carrying the boat at reasonable speed on the highway is provided. This trailer is backed into the water for loading and unloading.

The supersonic echo sounding equipment being used is a Submarine Signal Co. Model 808-J. As previously mentioned, both inboard and outboard oscillators have been provided with this sounding equipment. Experience has shown that the outboard oscillators give a better-defined record than the oscillators installed in the hull of the boat. This may be due to the fact that the hull is not of model dimensions. The sounding equipment is of the portable type and is not installed permanently in the survey craft. An NK-2 model sounder manufactured by Bloodworth Marine Co. is maintained in the laboratory in working order as standby equipment.

A very useful piece of equipment for a survey party has proved to be walky-talky radios. This means of communication enables the boat party and the instrumentmen on shore to maintain conversational contact with one another, thereby reducing hand signals and misunderstandings. The equipment used is former Army Signal Corps radio receivers and transmitters and is operated on the frequencies assigned to the Bureau of Reclamation. These radios are used to supplement the signals sent and received between the boat and shore parties and to check data as taken.

The hydrographic party for the sedimentation investigations consists of from three to five men specially trained for their duties in this particular kind of work. Since the boat crew also does the above-water surveys, it is necessary in most instances to supplement the crew with personnel obtained locally or borrowed from nearby projects. It is desirable for the recorder operator, or some other man in the party, to have some knowledge of radio and elec-

tronic circuits in order to maintain the supersonic echo sounding equipment, the radios, and other electrical devices used by the party.

In a number of the surveys the water surface of the lake varied considerably during the time the surveys were being made. In these instances it was necessary to supplement the sounding charts at each end of the ranges by land surveying. This surveying was done in the conventional manner by using transit, rod, and level, or alidade and rod. No significant differences were noted between the profiles obtained by the conventional methods and those obtained by the use of the echo sounder where they overlapped. In many instances profiles were intentionally overlapped to provide a check. Since the lake stage usually fluctuates during the period in which the survey is in progress, numerous check readings can be made using both methods on the same reservoir cross-sections.

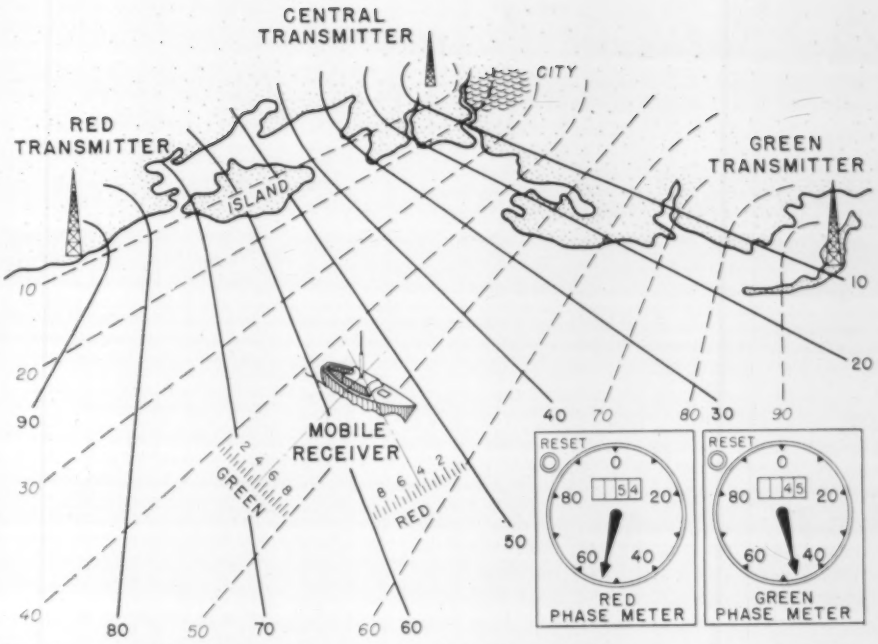


FIG. 4. LORAC, or "long-range accuracy," developed by Seismograph Service Corp., operates on medium frequencies and medium wave lengths, like Raydist. Boat installation is small but three land stations required are bulky and not easily moved, a disadvantage in sediment surveys.

Navy Cooperates in Lake Mead Survey

A silt survey is now being conducted on Lake Mead above Hoover Dam. This survey is being carried out under a cooperative agreement by the Navy, the Bureau of Reclamation, and the Geological Survey. Preliminary reports indicate that in the 13 years since completion of Hoover Dam, sedimentation deposits ranging in depth from as little as 4 ft in the Virgin River arm of the lake to as much as 260 ft in the Colorado River arm have accumulated in the lake. With the rate of Colorado River deposits averaging 400,000 tons per day, a total of about 2 billion tons has been deposited in the lake to date.

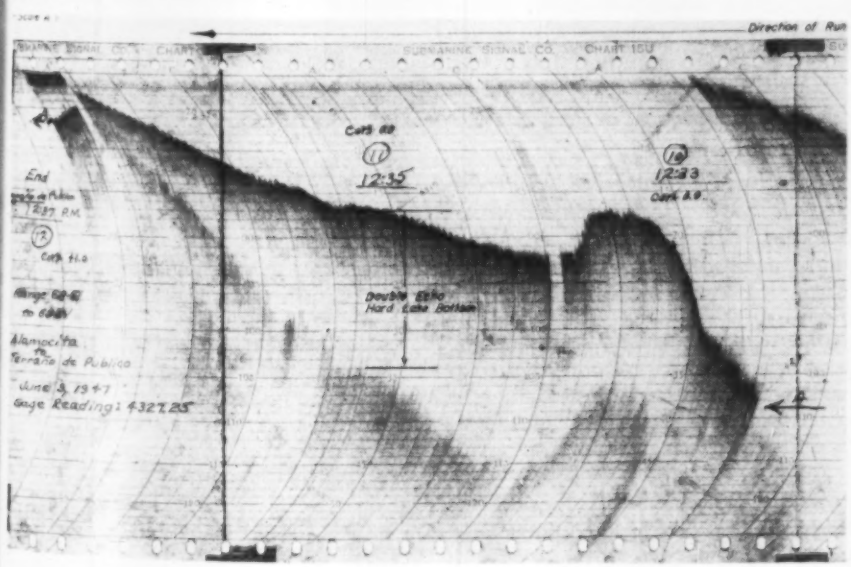
The experience of the Bureau of Reclamation has shown that echo sounding equipment provides a rapid and accurate means of conducting the under-water portion of reservoir sedimentation surveys. Caution must be exercised in the use of the equipment near the faces of dams, against steep cliffs, in swiftly flowing water, and in water containing air in any noticeable quantity. Frequent bar checks of the equipment will insure that the necessary constants have been correctly applied.

Although the results of the sedimentation surveys conducted to date have been quite satisfactory, engineers should not be satisfied that the ultimate has been reached but should be always on the alert for possibilities of further advances either by way of electronics or by extended application of the present equipment. Thinking along these lines, it appears possible that the supersonic echo sounding equipment now used to obtain the top of the sediment deposit in the reservoir may also be used to measure the depth of the deposit in the reservoir directly.

It is also possible that this echo sounding equipment may be used for detecting and measuring depth and extent of density currents in a reservoir such as Lake Mead. If so, it would provide a rapid and economical means of measuring and plotting these currents. Once the behavior of this phenomenon is understood, selected operation of gates and sluices might permit passage of considerable sediment through the dam. These potential uses of the instrument in question have been considered, and a limited amount of work has been done to determine their adequacy for such surveys.

There is a definite need for an accurate, continuous means of position finding as well as for a wider adaptation for the use of the present sounding equipment.

FIG. 5. RECORDING FROM Submarine Signal Co. Model 808-J Echo Sounder shows double echoes which indicate possibility of using method to measure depth of silt deposits directly. Trained crew can cover approximately 4 sq miles of reservoir in working day with this equipment.



Can Sediment Studies
Extend Reservoir Life?

MEASUREMENT OF SEDIMENT in rivers, reservoirs and harbors was the keynote subject of the Hydraulics Division meeting in Oklahoma City, which was presided over by L. G. Straub, chairman of the Division's Executive Committee. Silt, when washed off of land by rains and floods, results in damage to our whole economy, it was brought out. The process lowers the fertility of the soil; the eroded gullies make cultivation more difficult; the sediment deposited in river bars and on harbor bottoms must be dredged out to keep navigable channels open; and when deposited in storage reservoirs, the sediment gradually reduces the ability of the reservoirs to perform the functions for which they were built.

Methods and equipment for determining the amount and location of sediment deposits in harbors and reservoirs, and for measuring the bedload carrying capacity of rivers were explained in considerable detail in four papers presented at the Hydraulics Division meeting. In the first of these papers C. W. Thomas, Assoc. M. ASCE, Engineer of the Bureau of Reclamation, Denver, Colo., discussed "Sounding Sediment Deposits by Supersonic Methods." An article based on Mr. Thomas's paper appears in this issue. In the second, J. M. Caldwell, Assoc. M. ASCE, Engineer of the Beach Erosion Board, Washington, D.C., described the rise of echo-sounding electronic equipment in harbor work under the title, "Supersonic Sounding Instruments and Methods." "Methods Used by the Soil Conservation Service in Measuring Sediment Deposits" were presented by L. C. Gottschalk, head of the Sedimentation Section of the U.S. Soil Conservation Service in Washington, D.C.; and H. A. Einstein, Assoc. M. ASCE, who has been prominent in river silt researches at the California Institute of Technology and the University of California, addressed the Division on the subject of "Determination of Bed Load."

Joseph M. Caldwell

"The desirability of increasing the rate at which soundings can be made in hydrographic survey work probably has been recognized since men first began to chart the navigable waters of the earth," Mr. Caldwell explained. Submarine warfare stimulated the growth of our knowledge of under-water acoustics, he said, and led to the development of

Lorenz G. Straub, Chairman, Hydraulics Division; Director, St. Anthony Falls Hydraulic Laboratory, Minneapolis, Minn.

the echo-sounder now in use. "This device enabled extremely short time intervals to be measured, the measurement of the time interval being automatically converted to and observed as a depth measurement. Adapting features of the echo-sounder to shallow-water hydrographic studies resulted in the Model 312 Fathometer."

In describing this instrument Mr. Caldwell said that the essential components are a signal generator, an amplifier-recorder, a signal transmitter, and an echo receiver. The first two items, frequently boxed together, are referred to as the sounder. The last two are usually mounted together and are known as the transceiver.

In operating the echo sounder, the sequence in obtaining a sounding is as follows. The signal generator initiates, by electronic means, a short, strong impulse which is sent to the signal transmitter. Upon receipt of the electrical impulse, the under-water-mounted transmitter converts it into a sound wave which is directed toward the bottom. On reaching the bottom, the sound wave is reflected from it as an echo.

The echo is detected by the signal receiver, also mounted under water, which converts the echo into an electrical signal and sends it to the electronic amplifier. The amplifier makes the signal discernible on an indicator or recorder, which measures the time elapsed from the generation of the sound signal to the return of the echo, converts the time interval to the equivalent depth of water, and either gives a visual indication of it or records the depth.

These steps are repeated automatically by the instrument so that in shallow water more than 100 soundings per minute can be taken, within an accuracy of 3 to 6 in. in 50 ft of water, Mr. Caldwell stated. "The top layer of an unconsolidated mud bottom may return such a faint echo that the sounder may not detect the initial echo," he pointed out. "Instead the sounder may detect as the bottom a point down in the material which has become sufficiently consolidated to return a usable echo," a phenomenon which another speaker, Mr. Thomas, explained might be utilized to measure the depth of reservoir sediment deposits direct.

"The greater part of the hydrographic work done by the Corps of Engineers is done with the aid of echo-sounders. Dredging-contractor prejudice against being paid for work measured in this manner is being overcome because "experience shows that a properly operated sounder gives a fair and representative picture of hydrography."

L. C. Gottschalk

Reductions of up to 95 percent can be effected in losses of soil from corn, soybean and cotton land by proper crop rotation and tillage practice, Mr. Gottschalk told the Hydraulics Division. "Experimental data from plats and small watersheds indicate possible reductions of from 65 to 95 percent in the soil losses from these crops, depending on the nature of soils, slopes and practices used."

Outlining methods used by the Soil Conservation Service in accumulating data on rates of soil erosion from drainage basins, Mr. Gottschalk told the engineers. "The time has come when we need to emphasize not why surveys should be made but how and where they are to be carried out. There is a need for standardizing methods of making reservoir sedimentation surveys so that the results obtained by various federal and state agencies will be comparable and useful to all.

"In general, the purpose of a reservoir sedimentation survey is to

measure the accumulated volume of sediment in a reservoir during the period of storage record. This information is useful for: (1) Determining the prevailing and probable future sedimentation damages to a particular reservoir; (2) in combination with similar data from other reservoirs and suspended-load measurements, evaluating the effects of watershed and climatic factors on the rate of sedimentation; and (3) preparing regional sediment-production indices for developing design data.

"One of the objectives of reservoir sedimentation surveys from the standpoint of the Soil Conservation Service is to evaluate the effects of climatic and watershed factors on the rate of sediment production from a watershed. Such data are needed for determining the extent of sedimentation damages to downstream developments, for determining the nature and location of control measures, and for developing sediment-production indices useful in the design of reservoirs and other water-utilization projects. Therefore, no detailed sedimentation survey is made without at least a reconnaissance study, and preferably a detailed study of the climatic and watershed conditions which affect the rate of sedimentation in a particular reservoir.

"For any given climatic and soil condition, the following factors affect the rate of sediment production: (1) Size of drainage area, (2) land use, (3) slopes, and (4) channel density. Size of drainage area and land use are the predominant factors, and these are carefully determined whenever possible from aerial photographs and field inspection. Studies are now in progress to evaluate climatic and watershed factors separately for the development of design data and for determining the amount of reduction in reservoir sedimentation that can be brought about by watershed and channel-control measures. For example, in humid areas most of the sediment deposited in reservoirs is derived from sheet erosion on cropland, particularly from inter-tilled crops such as corn, soybeans and cotton. In more arid areas, sediment is derived mainly from channel erosion, which requires channel structures for adequate sediment control."

Hans Albert Einstein

"The two main purposes of bed-load determinations are to predict the life expectancy of reservoirs and the stability of stream channels," Mr. Einstein asserted in his address before the Hydraulics Division. "In both cases the sediment capacity of a reach of channel must be studied in connection with the sediment output of the watershed upstream."

"The term bed load describes that part of the total sediment load in a stream which moves in the immediate neighborhood of the bed, rolling and sliding on the bed, in contrast to the suspended load, which is vertically supported by the flow itself," Mr. Einstein said. If it is the object of an investigation to find the total load of a stream consisting of bed load and suspended load, this can be done by finding a section in the stream of high turbulence where all sediment goes into suspension and can be measured in a suspended load type of sampler.

He described several bed-load samplers, one of which, the slot-type sampler, is especially adapted for sampling small flashy streams. "It consists of a hopper-shaped box which is permanently buried in the stream bed. All sediment which moves as bed load on a stream bed settles into the hopper as soon as it reaches the hopper's edge and is then pumped continually to a measuring device." The speaker explained that the width of the slot in the direction of stream flow must be kept reasonably small so that suspended material will jump over the opening.

In design problems, where the direct measurement of bed load is impossible, an analytical approach must be applied by calculating movements of each grain size. "The behavior of any one particle moving as bed load can be explained," he said, "by laws based on the fundamental assumption that the probability of a particle's being settled out on the bed or being picked up from the bed is constant over the entire bed area," which asumption holds equally true for particles in a mixture of entirely different grain sizes.

Actual transport of a given grain size is obtained, he asserted, by proportional reduction to the frequency of occurrence of these particles in the bed. The total transport of all sizes is found by simply adding together the fractions.

Tests of Soils Save Construction Costs
In Oklahoma, Texas and Kansas

ANALYSES of Oklahoma, Texas and Kansas soils and the development of design criteria were discussed in two papers delivered before the Soil Mechanics and Foundations Division in a session presided over by R. E. Means, chairman of the Oklahoma Section's Soil Mechanics Committee. The first paper was "Design of Flexible Pavements Based on Results of Triaxial Tests," by H. E. Worley, Assoc. M. ASCE, of the Kansas State Highway Commission. The second paper, "Foundations of Permian Red Clay of Oklahoma and Texas," was by James V. Parcher, Assistant Professor of Civil Engineering, Oklahoma A. and M. College, who co-authored the paper with two other professors from the same college, W. H. Hall, Assoc. M. ASCE, Associate Professor of Architectural and Civil Engineering, and R. E. Means, M. ASCE, Professor of Architectural and Civil Engineering.

Herbert E. Worley

"Over eleven thousand triaxial compression tests have been conducted in connection with the design of one thousand miles of highways," claimed Mr. Worley. "Less than one percent of the highways built according to the design for flexible pavements developed by the Kansas State Highway Commission have shown distress."

Soils are now evaluated according to their physical properties, he said, either for foundations or as materials of construction. Some of the tests which evaluate soils for engineering purposes are triaxial compression, box shear, plate bearing, cone bearing, California bearing ratio, consolidation, compaction, plasticity and grading.

Mr. Worley explained that under field conditions the materials surrounding a column of soil under a

wheel load provide lateral support to it. In a similar manner, a triaxial compression test provides lateral support to a specimen of the soil while a vertical test load is applied.

R. E. Means, Chairman, Oklahoma Section Soil Mechanics Committee; Professor of Architecture and Civil Engineering, Oklahoma A. & M. College, Stillwater, Okla.

The test allows expulsion of water from the specimen as the test progresses, similar to the loss of water from the soil under field conditions.

After describing Kansas soil testing methods in detail, Mr. Worley emphasized that such tests provide a sound basis for economical pavement design for flexible pavements.

J. V. Parcher, W. H. Hall, R. E. Means

In designing foundations on the Permian red clay which occurs in central Oklahoma and north central Texas, the authors stated that the engineer should:

"1. Use independent footings designed for heavy contact pressures (5,000 lb per sq ft or more).

"2. Locate footings deep beneath the surface, as near the water table as possible.

"3. Produce as nearly saturated condition of clay as possible before erection of the structure.

"4. Support all parts of the structure on a structural frame so that all footings carry approximately the same total load.

"5. Arrange for providing water to prevent drying out during dry periods and for taking off excess water during wet periods.

"6. Provide joints so that differential movements will not injure parts of the structure."

To develop these criteria, the authors divided the paper into three main sections which they outlined as follows:

"1. A general discussion of the physical properties of the Permian red clay, a listing of specific examples illustrating the type of damage caused by the action of the clay in its climatic environment, and a discussion of the methods and details of construction to prevent damage to buildings.

"2. The presentation of specific data concerning the specific properties of different samples of Oklahoma clays in the vicinity of Stillwater.

"3. A description of the methods and devices for measuring the vertical movements of structural parts of buildings with reference to the first layer of rock beneath the footings, and a presentation of some data showing the amount of movement experienced in the buildings under observation."

Valuable Property

Made Available to Cities Through Consolidation of Railroad Facilities

COOPERATION between railroads and cities in planning property use was the keynote of the session presided over by Lawrence V. Sheridan, chairman of the Executive Committee of the City Planning Division. The attending members of the Division heard two papers dealing with the utilization of railroad property in city planning. The first paper, "Development of the Oklahoma City Civic Center," was presented by S. Herbert Hare, architect and city planner of Kansas City, Mo. Mr. Hare was followed by Harland Bartholomew, M. ASCE, planning consultant of St. Louis, Mo., who spoke on "Railroads as a Part of the Comprehensive City Plan." The remainder of the session was used for a discussion of the "Economic Aspects of Transportation on City Development."

S. Herbert Hare

"Through long-range coordinated planning, Oklahoma City solved a serious railroad and traffic problem, greatly increased values in the central business district, and provided, without extravagance, a convenient and dignified setting for public buildings," stated Mr. Hare.

The planning began when a $4,000,000 bond issue was voted for removal of the tracks of the Chicago, Rock Island and Pacific Railway through the business district. The land thus made available is occupied now by needed municipal buildings. By planning the group of buildings as a unit, the speaker pointed out, a pleasing and efficient civic center was developed. A bond issue totaling $1,788,000 to construct the buildings at a total estimated cost of $3,300,000 was approved, part of the costs being covered by grants from the Public Works Administration.

Some abutting properties, he said, have already been remodeled to take advantage of this new frontage along the newly developed roads around the civic center buildings, thus improving the setting of the public buildings.

Harland Bartholomew

Consolidation of facilities and planned location of tracks and terminals are necessary to an efficient and genuinely satisfactory city plan, Mr. Bartholomew pointed out. Utilization by railroads of valuable

Lawrence V. Sheridan, Chairman, City Planning Division; Planning Consultant, Indianapolis, Ind.

property in business districts and residential areas is an impediment to a community's growth and a burden on its economy. The rail-

roads themselves suffer from the added costs of gatekeepers, slow speeds through cities, and the inefficiency of duplicated facilities among competitors.

Dealing chiefly with the effect of railroad development on the general welfare of the community, the speaker declared that the main matters of concern are: (1) Relation of the railroads to the urban pattern, (2) elimination of grade crossings, and (3) location and adequacy of terminal facilities.

Several cities have already developed old railroad sites. Oklahoma City is an excellent example, having removed the Rock Island tracks located in the center of the business district and erected several municipal buildings on the property thus made available. Mr. Bartholomew also mentioned the "recent city plan of Dallas, which provides for the eventual abandonment of four railroad lines and the rerouting of traffic over other existing lines better related to the city's future development."

In conclusion the speaker asserted that "cities and railroads are each dependent upon the other. Both should be concerned in bringing about a more efficient and genuinely satisfactory physical plant. A carefully prepared city plan will disclose the type and character of improvements of mutual concern. By cooperative advance planning and budgeting it should be possible to make steady progress in carrying out these plans."

Push-Button Air Traffic Control Predicted Within Fifteen Years

COMPLETELY AUTOMATIC, all-weather, push-button control of air traffic is now planned by the Radio Technical Commission of Aeronautics for nation-wide installation by 1963, said George Kriske, Chief, Air Route Traffic Control Section, 5th CAA Region. In his paper, "Trends in Air Traffic Control," presented at the Air Transport Division session, Mr. Kriske also described some of the electronic devices already developed and others still under investigation. The session was presided over by Alfred J. Ryan, chairman of the Division's Executive Committee.

The dangers of high obstructions in areas adjacent to airports were cited by Isaac L. Ledbetter, Jr., Assoc. M. ASCE, in his paper, "The Effect of Obstructions and Zoning Upon Air Transportation." Mr. Ledbetter, who is Chief, Air Naval Facilities Planning and Control Staff, Civil Aeronautics Administration, reviewed the major regulations and recommendations concerning zoning which have been developed or proposed.

"Influence Charts for Concrete Pavements," by Gerald Pickett, Professor of Applied Mechanics, Kansas State College, and Gordon K. Ray, Engineer, Highways and Municipal Bureau, Portland Cement Association, was the third paper presented at the Air Transport Session.

George W. Kriske

"A push-button system of air-traffic control whereby electrical and mechanical devices will perform the majority of tasks that now require human effort" is now planned by the Radio Technical Commission of Aeronautics, Mr. Kriske stated in his paper. It is proposed that this push-button control will be developed through a transition program which will put into use "many improved types of equipment which are ready for operation," and an "ultimate program, which is the completed all-weather system, employing devices and equipment which in many cases are still in the process of research and experimentation," although "the technique and methods involved . . . are already known to science and merely require adaptation."

Among the many developments now ready for use, he said, is "the omni-range, which enables the pilot to fly a selected course to or from the station in any direction, as compared with the old-type range which provided only four courses. In addition, the new omni-range operates on static-free, very high radio frequencies with visual indications." A further refinement shows the pilot approximately how far and in which direction off course he is.

Alfred J. Ryan, Chairman, Air Transport Division; Consulting Engineer, Denver, Colo.

Another development described in the paper was distance measuring equipment, "DME," located at each of the omni-range stations. "When using the DME feature at a particular omni-range location, the pilot is able to see exactly (on a dial in the cockpit) what his distance to that station is at all times." To be used in conjunction with the omni-range and DME is the course-line computer which solves the triangulation necessary to fly a straight-line course to a destination other than an omni-range station.

"Instrument Landing Systems, 'ILS,' will provide pilots with precise radio guidance for their approach to the runway so that the aircraft will be aligned with the runway for a landing when the pilot has completed his let-down through the weather conditions which obscure his vision." This system may be used to control the automatic pilot so that the plane can be brought down the glide path without the help of the pilot. "There are 79 ILS installations in operation at major airports in the U. S. at present," Mr. Kriske stated.

Another technique used to guide planes onto the runway, the speaker said, is ground-controlled approach radar, "GCA" which locates aircraft on a radar screen, and the pilot is directed in by radio telephone from the control tower. There are three GCA installations in operation now. Radar will eventually be used to locate all aircraft in the area at all times and guide them into safe lanes. Smaller, lighter and cheaper models of all this equipment are being developed for installation in small private airplanes. "Traffic control in the ultimate system will be accomplished for the most part by a series of auto-

(*Continued on page 94*)

Engineers' Notebook

Graphical Method Determines Truss Deflection Influence Lines

S. F. BORG, Assoc. M. ASCE
Assistant Professor, Naval Postgraduate School, Annapolis, Md.

DEFLECTIONS OF TRUSSES can be determined graphically by means of the well-known Williot diagram combined with the very elegant Mohr correction curve. It will be recalled that the Williot diagram by itself gives the true relative deflections for a given truss on the basis of an assumed fixed point and a fixed member. Thus the truss of Fig. 1, with point A and direction AB assumed fixed, will deflect as shown by the dotted lines, and the Williot diagram will correctly show this deflection pattern. The true deflection of point D, however, must have a zero vertical component, and it is this fact which is the basis of the Mohr correction. The true deflections are then determined as the distances between the corresponding points on the Williot and Mohr diagrams.

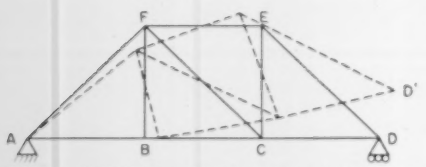


FIG. 1. TRUSS, with point A and direction AB assumed fixed, deflects as shown by dotted lines, and Williot diagram will correctly show this deflection pattern.

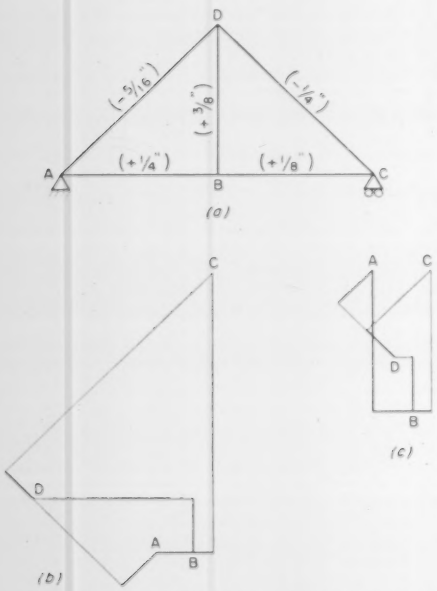


FIG. 2. DIAGRAM FOR SIMPLE TRUSS with straight bottom chord, *(a)*, shows member deformations. Assuming point A and line AB fixed, Williot diagram is drawn, *(b)*. To draw true Williot diagram, *(c)*, start with point A and obtain true location of point B by drawing horizontal component equal to elongation of member AB and vertical component equal to vertical deflection of B as obtained from Fig. 2 *(b)*.

Construction of Diagram

It is possible, for trusses with straight bottom chords, to construct a single complete diagram with all deflections correctly given with respect to the proper fixed point and line. The deflections are then obtained by measuring the distances from the fixed point to the desired points. The construction for a simple truss, Fig. 2 *(a)*, proceeds as follows:

1. Construct the Williot diagram assuming point A and line AB fixed, Fig. 2 *(b)*.
2. Measure the distance corresponding to DD'_V on Fig. 1.
3. The true location of point B on the Williot diagram is now known. Its horizontal component is equal to the elongation of member AB and its vertical component is equal to DD'_V divided by n, in which n is the number of equal panels.
4. Draw the Williot diagram, Fig. 2 *(c)*, starting with point A and locating point B in accordance with Step 3 above. All points are now shown with true deflections relative to A, and the line AC fixed.

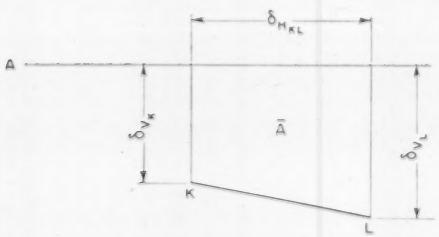


FIG. 3. AREA under typical truss points K–L equals work done by uniformly distributed load in panel K–L of value per unit length equal to $\left(\frac{P}{Ea}\right)_{KL}$.

Numbers in parentheses on the truss members in Fig. 2 *(a)* represent member deformations determined in the usual manner. A partial check on the construction is the fact that the final location of point C on the curve of Fig. 2 *(c)* should be on a horizontal line through A.

Having the single complete diagram, a simple physical significance may be attached to the area between a horizontal line through the fixed point and the lines joining the bottom truss points. Consider, for example, the area under the typical truss points K–L shown in Fig. 3. This area is given by

$$\bar{A} = \frac{\delta_{H_{KL}}}{2}(\delta_{V_K} + \delta_{V_L}) = \frac{1}{2}\left(\frac{Pl}{Ea}\right)_{KL}(\delta_{V_K} + \delta_{V_L}) \quad \ldots (1)$$

which is equal to the work done by a uniformly distributed load in panel K–L of value per unit length equal to $\left(\frac{P}{Ea}\right)_{KL}$ in going through the deflection caused by the given external loads. The extension to all lower panels follows directly.

If, then, the complete curve is drawn for, say, a 1-lb load at any panel point, this curve in conjunction with the law of reciprocal deflections may be used to determine the deflection of this panel point under any given lower panel loading. For a given panel, the area of the unit load deflection diagram must be multiplied by $\left(\frac{w}{P/Ea}\right)$, in which all terms are the values for the given panel, P being the unit load value, and w a uniform load.

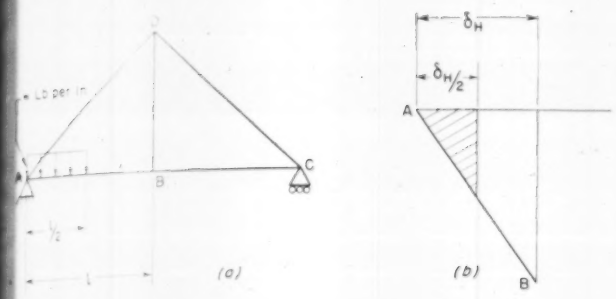


FIG. 4 (Left). DEFLECTION of point B due to loading in (a) is obtained by multiplying shaded area in (b) by $\left(\frac{w}{P/Ea}\right)_{AB}$.

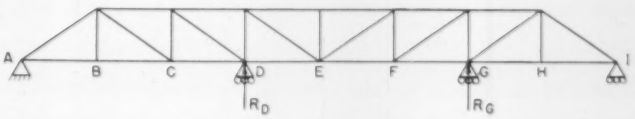


FIG. 5 (Above). DIAGRAM of statically indeterminate truss shows reactions R_D and R_G.

For example, to determine the deflection of the point B due to the loading of Fig. 4 (a), the shaded area of Fig. 4 (b) is multiplied by $\left(\frac{w}{P/Ea}\right)_{AB}$.

In solving for a statically indeterminate truss such as that shown in Fig. 5, complete deflection diagrams are drawn for 1-lb loads at each redundant, say D and G. Let δ_{DD}, δ_{GD} and δ_{GG}, δ_{DG} be the vertical deflections at D and G due to a 1-lb load at D and G, respectively. From the reciprocal theorem, $\delta_{GD} = \delta_{DG}$. Then

$$R_D\delta_{DD} + R_G\delta_{DG} + (\delta_D)_w = 0. \quad (2)$$

$$R_D\delta_{GD} + R_G\delta_{GG} + (\delta_G)_w = 0. \quad (3)$$

where

$$(\delta_D)_w = \sum\left(\frac{w}{P/Ea}\right)\bar{A}_D$$

and $(\delta_G)_w$ is obtained in a similar manner. Solving Eqs. 2 and 3 we obtain,

$$R_D = \frac{-(\delta_D)_w\delta_{GG} + (\delta_G)_w\delta_{DG}}{\delta_{DD}\delta_{GG} - (\delta_{GD})^2}. \quad (4)$$

or

$$R_D = K_1(\delta_D)_w + K_2(\delta_G)_w \quad . \quad (5)$$

and

$$R_G = K_2(\delta_D)_w + K_3(\delta_G)_w \quad . \quad (6)$$

in which the K terms are independent of the truss loading.

What Makes a Good Engineering Report?

F. W. EDWARDS, M. ASCE

Director, Department of Civil Engineering, Illinois Institute of Technology, Chicago, Ill.

ABILITY TO PREPARE good reports is a valuable asset to the engineer in a wide variety of fields. The following discussion of some of the essential elements of good report writing is based on a more comprehensive memorandum issued by the writer to section heads in the Omaha District, Corps of Engineers, during preparation of project reports for the Missouri Basin Project. In a longer form the material has been used also by classes at the Carnegie Institute of Technology and the Illinois Institute of Technology.

Many elements of a good report are taken for granted in this discussion, such as adequate command of English to express the intended meaning. Other elements are less obvious, but no less important, if the main purpose of the report is to be achieved. Written expression will be more effective if careful attention is given to a prepared outline; to topic paragraphs and sentences at the beginning, respectively, of divisions and paragraphs; to transition sentences or paragraphs which help to tie the report together; to a simple style of writing; and to the accurate use of words. Tabulations of data and graphic illustrations often add greatly to the effectiveness of reports. Extraneous material should be excluded.

Prepare Report to Serve Definite Purpose

Normally the purpose of a report is to guide its readers in choosing a course of action. The writer, therefore, should reach definite conclusions himself and should state these conclusions clearly, concisely and accurately.

Not only must the report as a whole serve a definite purpose but each part of it must serve a definite purpose. Most reports have eight main parts. The **title page** (1) and **table of contents** (2) are self-explanatory. The **synopsis** (3) presents a very brief statement of the subject covered and the principal conclusions reached. The **introduction** (4) should deal with three important items: (a) The nature and limitations of the subject discussed, (b) the purpose of the report, and (c) the main divisions of the body of the report.

The **body of the report** (5) usually is made up of several major divisions. It may refer to the bibliography and appendix for details but it alone should furnish all the information necessary for a complete understanding of the problem.

The **closure** (6) summarizes the data and lists the conclusions to help the reader retain the important points. The **bibliography** (7) indicates the source and extent of the published material on the subject. The **appendix** (8) contains photographs, sketches, drawings, charts and graphs, which are referred to in the text.

> **"SOMETIMES half a dozen figures will reveal, as with a lightning flash, the importance of a subject which ten thousand labored words with the same purpose in view, had left at last but dim and uncertain."**
>
> **—Mark Twain**

Organize Material to Advantage

An essential step in preparing a report, but one often slighted, is adequate planning for presentation of the material to the best advantage, including a determination of the main divisions and classifications of the data. Then the order of these

divisions in the report must be decided.

In determining the order of presentation, the following considerations will act as a guide: Time sequence, cause and effect, location, degree of importance or magnitude, degree of reader familiarity, degree of reader interest, similarity one to another, and common sense.

Probably the "time sequence," where applicable, is the easiest to follow, but presentation on this basis may not serve the purpose of the report. "Cause and effect" contains the time element, because effect follows cause. In a report, however, the effect may be referred to first and an explanation of the cause reserved for later discussion. The point is that cause and effect belong in some sort of sequence which can be easily understood by the reader.

The word "location" refers to spatial relationship. For instance, if a report is being prepared on the facilities housed in a row of buildings, it would be logical to start at one end of the row and proceed toward the other end in regular order. "Degree of importance," or the magnitude of a value, often furnishes a logical basis for the arrangement of items, although the most important may come first in some cases and the least important in others. "Degree of reader familiarity," "degree of reader interest," and "similarity of one item to another" are self-explanatory reasons for determining the order of material. The expression "common sense" refers to the element of good judgment, which is the final court of appeal. It is particularly valuable in cases where special reasons exist for choosing some particular order of presentation.

Analysis of material with a view to its classification and assembly is facilitated by use of the loose card system, which permits rearrangement of subjects until the best order is found. After the data have been analyzed, an outline should be prepared with the following main purposes in mind:

1. Discovery of gaps in the material which must be filled.
2. Discovery of items on which the writer's ideas may not be entirely clear and which call for further consideration before work on the report can continue.
3. Creation of a simple guide for use in the actual writing of the report.

Use Tabulations and Graphs Where Feasible

Tabulation of data is a decided aid in presenting a report. Tabulations may be simple or complicated but considerable thought should be given to the organization of the material in order to make the tabulation as simple as possible. In general, the left-hand column should list the independent items and the columns to the right should list those progressively more dependent. In selecting the order in which to list the material in the left-hand column, the principles previously enumerated for presenting material in the main report may be followed, such as time sequence, cause and effect, etc.

Graphic illustration includes photographs, sketches, drawings, charts, and graphs or curves. Illustrations should be used whenever they can convey information more effectively than complete sentences or tabulations. For instance, a description can frequently be greatly simplified by reference to a clear photograph.

It is evident that comprehensive descriptive titles or some other clear method of identification is a "must" for all illustrative material. Nothing is more disconcerting to the reader than an illustration, no matter how excellent, which is not labeled clearly and tied in with the discussion it is intended to clarify.

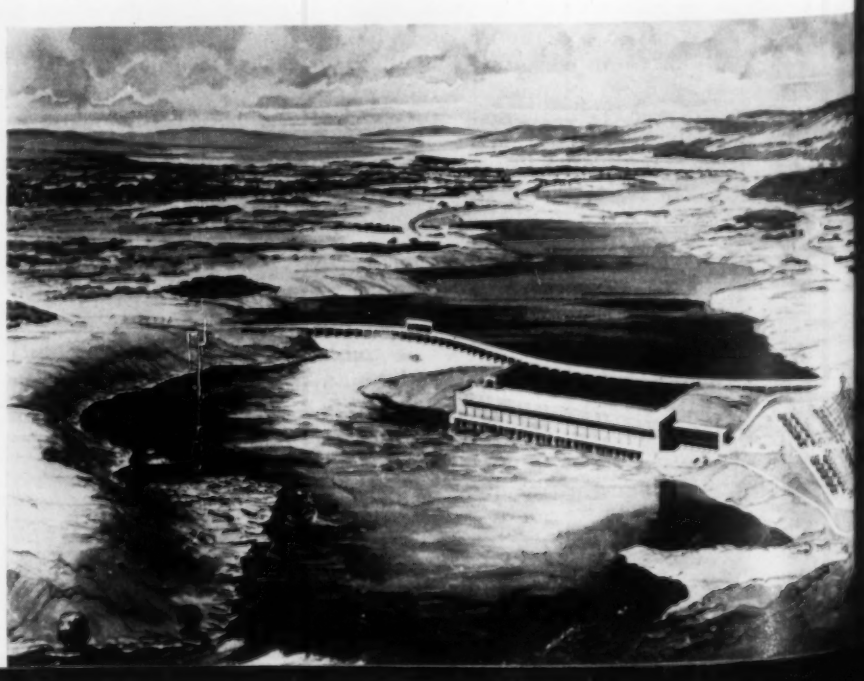
Exclude Extraneous Material

"Sketches" are considered here as small drawings showing only the outline features of a design or structure, as distinguished from "drawings," which are more complete. In preparing both sketches and drawings, care should be taken to exclude material extraneous to the purpose of the report.

Although the designations "charts" and "graphs" are often used synonymously, it is convenient here to consider charts as a graphic representation not involving the construction of curves on coordinate paper. Examples are the organization chart, bar chart and pie chart. Graphs or curves are considered as involving the plotting of relationships between two or more variables. In choosing and preparing illustrations for a report, as in preparing the rest of the material, the main purpose of the report should be kept continually in mind.

International Dam in Africa Planned to Cost 48 Million Dollars in First Stage

IRRIGATION and power-generation scheme launched by governments of British Uganda and Egypt consists of enormous dam at Owen Falls, Jinja, British Uganda, to regulate level and discharge of Lake Victoria into White Nile. Project, which compares in size with TVA in United States and Dnieper Dam in Russia, is expected to increase cultivatable area of Egypt from 5.9 to about 7 million acres, and that of Sudan from 862,000 to 2.5 million acres. Electricity will be provided for British protectorates of Uganda and Tanganyika and possibly Belgian Congo. Of estimated 48-million-dollar cost of first stage, Egypt is to contribute 16 million, Uganda 32 million. Six turbines would have output of 15,000 kw each.



...THE READERS Write

Advises Care in Concrete Encasement of Riveted Steel Plate Pipes

To the Editor: Hydraulic and hydroelectric engineers may be interested in a method of minimizing, if not eliminating entirely problems arising from embedded riveted steel plate pipe, such as penstocks in dams or tunnels, and especially riveted steel plate scroll cases.

In hydroelectric powerhouses requiring riveted steel plate penstocks, it is a common practice to continue the riveted steel plate work in the form of scroll cases around the turbine speed rings. These scroll cases, together with steel plate draft tube liners and steel plate turbine pit liners, are fastened to the steel speed rings, and encased in a concrete mass.

Since the scroll cases are continuations of pressure conduits, they are designed for full hydraulic load. In many cases the designing engineer endeavors to design the encasing concrete to withstand the same hydraulic loads.

Water-tightness tests of embedded riveted steel plate pipes or scroll cases can be accomplished only by the penetrating oil test. This is never a conclusive test since a pipe may start leaking after the pressure is applied. In cases where expansion and contraction take place, a pipe may start leaking after some movement in the joints has occurred. That leakage in such plate structures causes a problem is manifest by the efforts of designing engineers to provide some means of combating or relieving it by a collection or drainage system. This system works well for from three to five years, or until the calcification of water leaking through the concrete mass closes it up for good. From then on the leaking water, under pressure, seeks its own way out by cracking the concrete. This works until calcification closes the crack and a new path or crack is formed, and so on.

Powerhouses with comparatively shallow regulating reservoirs, or where the water changes from 50 to 100 deg in temperature of a 10-ft-dia pipe about 100 deg will tend to increase its diameter from $^1/_8$ to $^1/_4$ in. The force created by this tendency added to the force created by water pressure tending to enlarge the diameter of the pipe still further is, in many cases, sufficient to overcome all outward resisting loads, thus resulting in cracked concrete structures.

Riveted steel pipes, such as penstocks and scroll cases, should never be encased in concrete except where connections between pipe and concrete structures are made. The advantages of this procedure are many:

1. With the pipe exposed, it can be painted and maintained.
2. Testing can be done after the structure is completed and under water pressure.
3. Any leak that develops at any time can be repaired by outside caulking.
4. Pipes of small diameter connected to larger pipes are free to move and are not sheared off when the large pipe breathes.
5. Large-diameter pipe or scroll is free to breathe due to change in temperature, water pressure or a combination of both.

Other advantages such as ease of pipe inspection, economy in construction, are incidental.

Henry Miller, M. ASCE
Chicago, Ill.

Where Is the Corner?

To the Editor: "Field Notes," I was told, when it was decided to survey the line between our property in Shasta County and the adjoining section, "are the notes prepared by the surveyors who originally surveyed this territory for the United States government back in the seventies and eighties. They are supposed to give the engineer all the information needed to travel over the route originally traveled and reestablish the lines and corners."

Our engineer and his crew arrived at our place with their field notes, maps and instruments prepared to go to work. At this stage of operations, I began to suspect that field notes were carried more out of courtesy to the original surveyors than for any great value to the work to be done. The first question I was asked was, "Where is the Corner"? Had I the slightest idea of the whereabouts of any of our corners, it is doubtful that any engineer would have been called to do the work, for with a definite corner, any good timber cruiser with a compass could have established a line accurate enough for my purpose, but it seems that even an engineer armed with field notes and maps must have a corner from which to begin operations.

We then consulted several of the neighbors, timber cruisers and others and learned that there was a corner, not a government marker, but a corner established by the engineers of a power company in about the same way that ours was to be established. We found the corner and appealed to the field notes for aid in running the line. Two days were consumed in determining what was termed an approximate line and finally at the proper distance from the starting point, a spot was marked where a corner should be. The field notes referred to trees that would be found here, but no single tree or group of trees corresponding to those mentioned in the notes could be located, though the area was searched 200 ft in all directions.

At this point in our labors, for I had accompanied the surveyors armed with an axe with which to assist in clearing the way, I was informed that field notes were at best very unreliable. It seems that the original surveys were contract jobs and that some of the contractors were careless, if not downright crooked; that many of the notes had been written in the warmth of a hotel room or the comfort of a cozy bar; that experience had taught present-day surveyors that if anything appeared in the notes that concurred with their findings, well and good; and if anything appeared that did not, well, that item might be questionable.

The next step was to establish another line in the opposite direction in the hope that the point to be set up would coincide with the one already found, so another corner from which to start must be located. More inquiries from the neighbors disclosed that there was another corner in the direction indicated by a point where several fences came together. This must be a corner for the spot was on meridian, according to the maps. After a much labor, we arrived at the spot, but found no government marker—just one old tree in the fence corner that bore the marks of many timber cruisers. Using this tree as a witness tree and with the help of the despised field notes, we manufactured a corner from which to start the back track. Another day passed before

we finally reached a point the proper distance from our starting point, in a fairly good line with the first temporary corner established but about 600 ft short of it. While brushing this mile, I learned that no surveyor worth his salt would climb down and up the sides of a gulch that we had crossed without making some mention of his feat in the field notes, but no such notation occurred. It may be due to this oversight that our surveyors decided to ignore the item in the field notes to the effect that the point we had just reached was 1.5 chains from a creek, which strangely enough, was almost correct, and to assume rather, that the notation should in all probability be 15 chains which would more closely bring the two potential corners together. This line of reasoning escaped me entirely, that is, unless either or both of the starting points were in error or we had not correctly measured the distance between them.

Two more days were devoted to making another line at right angles to the line already established, using another corner not definitely a government marker as a starting point. The results this time were also far afield, the end of the line being about 400 ft beyond the line and about 100 ft to one side of the first corner. Now, what to do! Three separate and distinct spots where the corner could be with respect to the several starting points had been established but, wait, a very simple solution to the vexing problem was at hand. One of the neighbors, who happened to be the other interested party, suddenly thought of a man, born and reared in these parts, who claimed to know the location of every corner in the county. Why not consult him?

Two days later this gentlemen met us as we gathered around the first temporary corner. When asked if he could point out the location of the original corner, he carefully scrutinized the "cat" marred terrain, the uprooted stumps, allowed his gaze to wander to the distant hills on all sides and then, after several moments of silent thought, pointed to a spot at our feet not 25 ft away from the surveyor's first corner. Quickly the engineer ordered a stake to be driven, quickly the old-timer's signature was appended to the form submitted by the engineer and the deed was done. My southwest corner was definitely established. That evening we started the fire with the field notes.

J. G. REYNOLDS

Whitmore, Calif.

Suggests Identity of Figure on ASCE Certificate

TO THE EDITOR: In connection with the "Society News" item on the identity of the figure on the membership certificate, in the March 1948 issue, and the subsequent discussion, I call attention to the following to suggest an identification.

In the late 80's or early 90's, the birthday of John Fritz was celebrated by a mock trial, in which Fritz was convicted of destroying agricultural land by building the Bethlehem Steel Works upon it. This brought out what amounted to a prose epic concerning Tubal-Cain, the first smith, the gist of which was that, when the benefactors of the race were presenting their credentials and after all the rest had done so, an unkempt individual bearing the marks of soot arose and stated that the gentlemen were correct in their statements and their contributions. But, he said "*I* am the smith, without the tools that I made not one of them could have accomplished his work."

The man whose picture is shown upon the certificate was intended to represent Tubal-Cain as the original engineer-builder of the first city, maker of the first tools, and instructor of men in the art of getting fire, the basis of civilization.

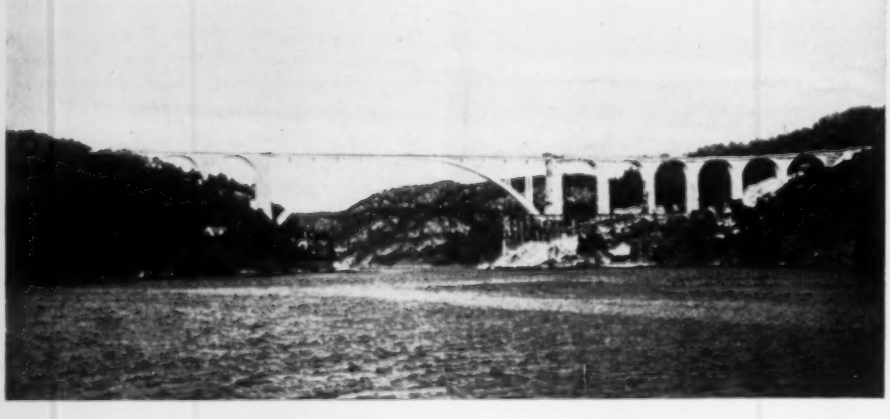
The late James Christie, a former Director of the Society and a Norman Medalist, attended this celebration which, by the way, was the inception of the John Fritz Medal, and it was in conversation with him concerning it that the information came to me.

J. H. GRANBERY, M. ASCE

Richmond, Va.

Long Concrete Arch Bridge Connects Norway and Sweden

SVINESUND BRIDGE, concrete arch structure with 492-ft-long main span, carries vehicular traffic over Svine Sund between Sweden and Norway. Letter to editor from subscriber Carl H. Gustafson, New York, N. Y., points out that this bridge is incorrectly stated to be between Sweden and Denmark in article by J. J. Polivka, M. ASCE, in January 1949 issue. On Norwegian side, Mr. Gustafson states, bridge is about 10 km from town of Halden, and on Swedish side, about 7 km from city of Strömstad. (Editor's Note: Error referred to is a typographical one, and occurs in box, page 40 of January issue. Photographs of Svinesund Bridge which appear herewith are used through courtesy of Mr. Polivka.)



SOCIETY NEWS

Spring Meeting Attracts 550 to Oklahoma City

A DIVERSIFIED TECHNICAL program, inspection trips, and social events, arranged under the auspices of the Oklahoma Section, attracted over 550 engineers and their families to the Spring Meeting of the Society in Oklahoma City, April 20–22. Heading the host committees were David B. Benham, general chairman, and Walter C. Burnham, co-chairman. Mrs. Webster L. Benham headed the large committee of women who entertained the lady visitors.

ASCE Technical Divisions holding sessions on Wednesday and Thursday were the Hydraulics, City Planning, Sanitary Engineering, Structural, Highway, Air Transport, Soil Mechanics and Foundations, Surveying and Mapping, and Construction. The latter Division held two sessions—one a joint meeting with the Sanitary Engineering Division. Write-ups of these ten technical sessions appear elsewhere in the issue (for page numbers see the Contents Page).

Contractor Addresses Construction Luncheon

Common objectives of the engineer and contractor in the interest of "more efficient and effective construction," were stressed by Warren S. Bellows, president of the Bellows Construction Co., of Houston, Tex., and past-president of the AGC, in the leading address at the Thursday Construction Luncheon. Calling attention to the tremendous development of the engineering profession and the contracting industry in recent years, Mr. Bellows said, "Modern construction is engineered construction." Similarly, the modern contractor "must have a highly skilled, technically trained and experienced organization if he is to stay in business," he added.

Mr. Bellows also referred to the work of the recently formed Joint Cooperative Committee of the ASCE and AGC, which will act as a clearing house for the interchange of information and ideas between the two groups. At present, he said, the joint committee is studying equitable forms of construction contracts and bidding and awarding practices, and seeking to interest young engineers in construction careers.

Hailing the closer cooperation between civil engineers and general contractors as a powerful future factor in increasing the efficiency of construction design and operations, Mr. Bellows said in conclusion, "The more closely we work together toward a common objective, the better the public will be served."

Joint Luncheon on Friday

In a review of Task Force reports to the Hoover Commission as they affect engineers, presented at the Friday joint luncheon with the Oklahoma City Chamber of Commerce, ASCE Past-President R. E. Dougherty urged engineers to give careful study to the various reports and the problems posed by attempts at government reorganization. Stating that the functions of the engineer are not confined to technical considerations, he declared that the profession must give attention also "to the broader economic and policy aspects" of the reports.

Two of the Task Force reports are outlined in detail in the March issue of CIVIL ENGINEERING, and major recommendations of the Hoover Commission report are summarized in the April issue.

Role of Sanitary Engineer Praised

The sanitary engineer has done much to make this country one of the best and safest places in the world in which to live, Louis R. Howson, Chicago consultant, said in a paper read at the Friday luncheon by Past-President W. W. Horner. By the reduction in typhoid alone since the turn of the century, 50,000 lives a year are now saved which would have been lost had sanitation and water-treatment practices not been improved, he stated. There were eight epidemics of cholera in the United States from 1832 to 1873, but there have been none since. On a world scale, he pointed out, improved water supply and sewage disposal have largely eliminated the plagues that used periodically to wipe out great portions of the population.

"The improvement in sanitation has not been accomplished without large expenditures," Mr. Howson noted. "The cost of the public water supplies, sewerage systems and sewage treatment plants in the United States probably approximates $20,000,000,000, the equivalent of some $200 to $250 per capita of urban population served."

Emphasizing the point that in this country "water works and sewage disposal are big business," he said, "the tonnage handled by the water works, which is about the same as for the sewerage systems, is greater than that handled by any other business or industry. In tonnage it is four times that handled by the railroads."

Social Events and Inspection Trips

An especially gala note was given the Wednesday evening dinner dance by the presence of the Oklahoma City University

ASCE PRESIDENT FRANKLIN THOMAS IS INDUCTED INTO KIOWA TRIBE at Wednesday luncheon during Oklahoma City meeting, receiving Indian name meaning "Master of Nature's Resources." Society Director Webster L. Benham is pictured at far left, and Past-President R. E. Dougherty at right. Members of Kiowa Tribe represented are Chief and Mrs. Jasper Saunkeah.

mixed chorus of 50 voices, which featured selections from the musical, *Oklahoma*. The ladies were entertained at a special dinner and bridge on Thursday evening and by sightseeing excursions, luncheons, and a fashion show. Both groups had a chance to observe a "Sooners Day" parade on Thursday afternoon.

Inspection trips were made to the city's water-filtration and sewage treatment plants, the local air depot, and numerous projects under construction throughout the city. Another trip gave the visitors a chance to see a rotary oil rig in operation.

Student and Local Section Conferences

Delegates from 16 Mid-Western Sections took part in a Local Section Conference on Monday and Tuesday, preceding the general meeting. About 150 students from engineering colleges in the region met at a Student Chapter breakfast early Saturday. The rest of the morning was devoted to a conference on the vocational outlook for engineering graduates and other subjects of Student Chapter interest.

Service to Public Emphasized at San Diego Conference

Technical Sessions Highlight Sewers, Freeway, and Power

DURING THE PAST generation a strong consciousness of professional status has been developing among engineers, as well as among the other professions, ASCE President Franklin Thomas told the 350 engineers in attendance at the Second Annual California Conference of Local Sections, held recently in San Diego.

Speaking on "Widening Horizons of the Engineering Profession" at the Friday dinner meeting, culminating feature of the four-day conference, President Thomas said that this growing awareness of professional status was evidenced at the Inter-Professional Conference on Education for Professional Responsibility at Buck Hill Falls, Pa., last spring. At that conference, he said emphasis was on preparing the engineering student to achieve professional competence by learning from experience and on instilling in him "the inclination and qualifications for constructive citizenship and cultivated living." These aims, he declared, "constitute a major challenge and a wide extension of the responsibilities recognized by the colleges and universities."

Student Prizes Presented

At the conclusion of his talk, President Thomas presented prizes to the winners in the afternoon student paper competition. First prize went to John Heath, Jr., of California Institute of Technology, for his paper on "Water Supply in the Santa Barbara Area," and second prize to John D. Marchand, of Stanford University, for his treatment of the subject, "The Sacramento-Yola Port District and Its Deep-Water Channel Plan." The other contestants, who had been chosen to represent their colleges at the California Conference in preliminary competitions, were George V. Cashman, San Jose State College; William E. Harshman, San Diego State College; Robert Myer, University of Arizona; Malcolm Stephens, University of Santa Clara; Kristian Tonning, University of Nevada; Charles Vell, University of California; and Lowell Weeks, University of Southern California.

EJC Declared Essential

Steps taken toward unification of the profession in the past few years by formation of Engineers Joint Council were hailed by Executive Secretary William N. Carey in a talk on "Engineers and Their Societies," delivered at the Friday luncheon. Describing EJC as "a coordinating, supervising federation which, as occasion demands, requests the services of particularly qualified members of the profession to serve on special committees or for specific tasks," Colonel Carey stated that, "American engineering in war would have failed utterly had each engineer been permitted to work by himself alone.

"Engineers, organized over-all in four or five basic engineer services, each greatly subdivided but integrated with the war objective, succeeded magnificently. The proponents of EJC believe that this same pattern for unification can be successful among engineers in peace. This is a matter of first priority for consideration by every professional engineer."

As examples of EJC operation in the legislative field, Secretary Carey referred to its achievements in getting the engineering profession included in the provisions of the pending National Science Foundation bill, and in obtaining the professional employee provisions in the Taft-Hartley Act. At present, he said, the organization is alert to the menace of proposed legislation on Army reorganization that would "abolish by law several essential engineering arms and services of the Army as they now exist." This work of EJC, the speaker declared, "will indicate that a unified front publicly is essential to recognition of engineering as a profession."

California Projects Described

The $41,000,000 Hyperion Sewage Treatment Plant, now under construction for the City of Los Angeles, was described during the Friday technical session by Merrill Butler, deputy engineer for the city. Salient features of the project, which will be the largest high-rate activated sludge plant in the country, are a 12-ft-inside-dia submarine outfall a mile long, prestressed concrete tanks, a fertilizer production rate of 220 tons a day, a power plant of 15,200-hp capacity fueled on oil and digester gas, and a landscaped plant and grounds covering 76 acres. Mr. Butler stated that the plant's capacity to treat 245,000,000 gpd of sewage will lift a quarantine now imposed on a 10-mile stretch of the county's best beaches. The plant is expected to be in operation by 1953. For further details see the article by Lloyd Aldrich and H. G. Smith in the July 1948 issue of CIVIL ENGINEERING. Discussion of Mr. Butler's paper was led by Clyde C. Kennedy, San Francisco consultant.

In a paper on "A New Era in Highway Transportation," also given at the Friday technical session, Fred Grumm, deputy state highway engineer, advocated the "freeway principle," or the limited-access type of highway construction, as

FRED PYLE (LEFT), president of host Section at recent San Diego Conference, greets ASCE Director Sidney T. Harding, Berkeley (center), and former Director A M Rawn, Los Angeles.

M. J. SHELTON (CENTER), WHO HEADED COMMITTEE IN CHARGE OF ARRANGEMENTS at recent San Diego Conference of California Sections, is shown here with ASCE Director Julian Hinds (left) and President Franklin Thomas. Mr. Shelton is general manager and chief engineer of La Mesa, Lemon Grove & Spring Valley Irrigation District.

the best answer to today's highway problem. He stated that, with passage of the Collier-Burns Highway Act of 1947, providing for expenditure of 1½ billion dollars on highway improvement over a ten-year period, California took a leading position in the application of this principle. Hugo Winter, street and parkway design engineer for the City of Los Angeles, led the discussion of Mr. Grumm's paper.

As background material for a description of four new steam plants under construction by the Pacific Gas & Electric Co., I. C. Steele, vice-president and chief engineer, at the Saturday morning technical session, pointed out the growing demand upon the company for increased development of dependable power, caused by a 51 percent population increase in the demand area from 1940 to 1949. This will necessitate an addition of 1½ million-kw capacity, an increase of 125 percent over the total prewar power demand of the area, he stated. The total cost of this addition, of which 77 percent is being obtained by steam plants, is $600,000,000. Steam plants, Mr. Steele said, are rapidly becoming a dominant source of power in a system previously supplied almost wholly by hydroelectric installations. His paper was discussed by Wallace Chadwick, manager of the engineering department of the Southern California Edison Co.

1950 Conference to Join ASCE Spring Meeting

At the Saturday morning business session, resolutions were passed requesting all members to write their senators and congressmen, urging inclusion of the professional provisions of the Taft-Hartley Act in any new labor legislation, and asking the committee on ASCE reorganization to continue its studies. A decision was also made to amalgamate the 1950 California Conference with the Society's 1950 Spring Meeting, to be held in Los Angeles in April.

A Saturday afternoon boat tour of San Diego harbor installations and a number of excursions and sightseeing trips on Sunday rounded out the program.

Actions of Board of Direction Highlighted

A DIGEST OF the actions of the Board of Direction at its meeting at Oklahoma City, April 17–18, 1949, is reported by the Executive Secretary as follows:

Cooperation on Applied Mechanics

Upon recommendation of the Committee on Division Activities and the Executive Committee, ASCE voted to join the U.S. National Committee on Theoretical and Applied Mechanics. The Committee on Applied Mechanics of the Structural Division will represent ASCE on the newly organized U.S. National Committee.

Retention of Army Technical Services Recommended

Probable legislation for reorganization of the U.S. Army, with particular regard to its technical branches came in for unanimous criticism by the Board of Direction. Under this proposed legislation, not as yet printed as a Congressional Bill at the time of the Board meeting, the President of the United States would be authorized to abolish the existing technical army services such as the Corps of Engineers, the Signal Corps, the Quartermaster Corps, the Transportation Corps and the Ordnance Department or to combine any or all of the present duties of these branches with other general branches of the Army such as Infantry or Field Artillery. The Board authorized and directed its ASCE Committee on Military Affairs and the ASCE representatives on EJC to adopt all available means to assure, by statute, the retention and the further development of the professional and technical branches of the Army, and the maintenance of professional status to a high degree among the officers of the technical branches of the Army.

In connection with this Army reorganization proposal, the Board wished it to be distinctly understood that this legislation should not be confused with any possible legislation resulting from recommendations by the Hoover Commission. The proposed legislation to which the Board wishes all members of the Society alerted is purely an Army reorganization matter.

Reorganization of Executive Branch of Government Studied

After full discussion of the reports of the Hoover Commission as they affect national resources and the work of the engineering profession, the Board decided for the present that the Society should take no official position either for or against the recommendations of the Hoover Commission for the reorganization of the Executive Branch of Government.

Group Disability Insurance Proposed

Following a recommendation from the Committee on Employment Conditions, the Board gave approval to adoption of a plan for group disability insurance subject to approval by legal and actuarial advisers as to details of the currently proposed plan. The group health and accident insurance plan proposed is said to make such insurance available to all members on a group basis at a cost materially less than similar insurance might be had on an individual basis.

Operating Within Budget

The Board received a report from the Budget Committee indicating that operations to date appear to indicate that the Society will operate within the authorized budget for 1949, but recommended no changes in the budget at this time.

Reorganization Studies to Continue

The problem of redistricting and reapportionment of Directors on a proportional representation basis as provided by the Constitution again received the active interest of the Board. This matter had been held in abeyance, pending possible organizational changes in the structure of the Society. The Board decided to study these proposed organizational changes at length before taking further action, and to effectuate redistricting and reapportionment of Directors in accordance with present provisions of the Constitution at the earliest practicable date.

Report on Fees Adopted

An interim report by the Committee on Private Engineering Practice showing results of a survey covering fees for professional civil engineering service was

adopted by the Board and with the understanding that it would soon be published by the Society.

Study of Technical Publications Continues

A proposal for radical changes in technical publications procedures, as submitted by a special committee, was an item of major interest and discussion. This involves the possibility of publishing PROCEEDINGS papers as "Separates" instead of in volumes of PROCEEDINGS as at present. The plan envisaged by the committee would permit the publishing of upwards of 100 PROCEEDINGS papers per year, instead of approximately 35 as at present, at no greater net cost to the Society, and would permit complete coverage of papers to all members requesting them. The success of the plan proposed depends entirely upon the extent of cooperation which the Committee on Publications might receive from the several Technical Divisions. The Board authorized the special committee, with the Chairman of the Publications Committee and the Chairman of the Division Activities Committee, to determine the extent of proper cooperation in this effort by the Technical Divisions and to report later on the matter to the Board.

Two New Directors Appointed

The Board accepted, with regret, the resignations of two of its members, Edmund A. Prentis, District 1, and Lewis M. Gram, District 7, both of whom resigned because of ill health. The Board appointed Kirby Smith, of New York, to fill the unexpired term of Mr. Prentis and Gordon H. Butler, of Duluth, Minn., to complete Director Gram's term.

Mexico City Offers New Adventures to Summer Convention Visitors

CONSIDERABLE ENTHUSIASM IS being shown by ASCE members planning to attend the Summer Convention in Mexico City. Following announcement of the dates of this Convention, July 13–15, several Sections began making arrangements for group travel to the land of the sun.

Those able to attend will be assured a most cordial welcome by a local Committee on Hospitality and Entertainment, headed by Ing. Agustin M. Valdes, of Mexico City. His subcommittee chairmen include Sra. Valdes, chairman of Ladies' Entertainment; Ing. Alfonso Castello, chairman of Social Events; Ing. Aurelio Benassini, chairman of Technical Excursions; Ing. Armando Sontaeruz, Jr., chairman of Welcoming Ceremonies; and Ing. Juan Perez y Perez, chairman of Sightseeing Excursions.

Situated on a high plateau, surrounded by mountains and guarded by snow-capped volcanoes, Popocatepetl and Ixtaccihuatl, Mexico City provides an unparalleled setting for the Convention. There will be every opportunity for visits to these and other points of interest. The city itself is a thoroughly modern metropolis, where shoppers will find bargains galore. Prospective visitors are again reminded of the present very favorable rate of exchange—seven pesos to the dollar.

Scene of all convention sessions will be the new, ultra-modern Hotel Del Prado. Requests for reservations should be sent direct to Sr. Antonio Perez O., manager, Hotel Del Prado, Mexico City, with mention of proposed attendance at the ASCE Convention.

Excellent Travel Facilities

St. Louis will be the rail rendezvous for members from the North, Northeast, and Northwest for the "Texas Eagle," leaving St. Louis at 5:30 p.m. daily on the Missouri Pacific Railroad, which offers a through service to Mexico City. Members from the Southeast and Southwest who wish to join the party will board the "Sunshine Special," leaving San Antonio at 12:05 p.m. next day. Both the Pennsylvania and New York Central offer a good choice of rooms between New York and St. Louis, and the Pennsylvania Railroad also offers through service to San Antonio. Good facilities between Washington and St. Louis will be available on the Baltimore & Ohio. Members should make arrangements to fit their individual requirements with representatives of the railroad on which their travel will originate.

As noted in the April issue, a special Southern Pacific Railroad train is being made up in Los Angeles, with connections from San Francisco, or at Tucson and way points, for the convenience of those traveling by rail from the West Coast. Inquiries should be addressed to Ray L. Derby, Department of Water and Power, City of Los Angeles, Box 3669

MEMBERS MOTORING IN MEXICO WILL FIND WELL-SURFACED ROADS traversing interesting country. Highway between Jalupe and Veracruz (photo, lower left), completed in 1944, is typical. In right-hand view, tower of one of picturesque churches at Cuernavaca, a few miles from Mexico City, rises behind old stone cross in courtyard. Cuernavaca is site of famed Borda Gardens and Palace of Cortez.

Terminal Annex, Los Angeles 54, Calif.

Those wishing to join the cavalcade of motorists meeting in San Antonio to enjoy the Mexican trip together are reminded again that the person to contact is W. H. Furlong, U.S. representative of the Mexican National Highway Direction, 525 Bedell Bldg., San Antonio 5.

With several airlines operating through flights to Mexico City, travel by air will be especially easy. From any point in the United States it is only a one-day trip to the Convention City. Many of the flights make the trip over the mountains by daylight, so that passengers can enjoy the scenery.

Profession Held Aware of World Obligations at UNESCO Conference

ENGINEERING SOCIETIES ARE fully conscious of their international obligations, according to Robert M. Gates, member of the United States National Commission for UNESCO and EJC representative to the Second National UNESCO Conference, held recently in Cleveland. Speaking before delegates from all over the country on the relationship of the engineering profession to UNESCO objectives, he expressed the conviction that "the whole problem of world peace and prosperity requires for its solution the constantly increasing use of engineering."

Stating that "engineering has been defined as the utilization of the forces and materials of nature for the benefit of mankind," Mr. Gates declared that "the broad ideals of UNESCO can be realized only through the research, techniques, and creative work of engineering. Peace requires an economic foundation. We are told that half of the people of the world are living in conditions of destitution. We must help them, through their own efforts, to produce more food, more clothing, more materials for housing, and more mechanical power to lighten their burdens."

To meet the material needs of the world's present population is primarily an engineering job, Mr. Gates emphasized, adding that technical knowledge and assistance are so basic they should be principal features of the UNESCO program. "Workable plans and the execution of them require the cooperation of the best engineering talent our profession can offer," he declared.

As a prime example of progress toward international organization, Mr. Gates cited the work of Engineers Joint Council in cooperating with engineers in other countries "in the practical advancement of engineering and the use of engineering techniques"; in furthering technical education in countries where it has been unavailable; and in giving professional aid to countries in need of engineering services for their economic readjustment.

Stressing the importance of pooling engineering resources, Mr. Gates referred to the work of Overseas Consultants, a nonprofit organization formed under a government assignment to study social and economic conditions abroad. "It undertakes no engineering construction," he said, "but it suggests ways of financing and plans of performing construction work. In this way our government, through pooled engineering service, has been meeting requests from foreign countries for engineering aid."

In conclusion, Mr. Gates emphasized the need for the profession and the people generally to orient themselves to the demands of foreign customs and ancient cultures in bringing a new standard of living to less fortunate countries.

ASCE delegates to the Conference were Prof. G. E. Barnes and Frank C. Tolles.

Two New ASCE Directors Appointed by Board

AS ANNOUNCED IN the Secretary's abstract of Board of Direction action at the Oklahoma City Meeting, two new Directors were appointed to replace Edmund A. Prentis, District 1, and Lewis M. Gram, District 7, who resigned because of ill health. These are Kirby Smith, of New York City, who will fill the unexpired term of Mr. Prentis, and Gordon H. Butler, of Duluth, who will complete Director Gram's term.

Kirby Smith, vice-president of the Raymond Concrete Pile Co., is a graduate of the U.S. Naval Academy and Rensselaer Polytechnic Institute, with an early career in the Navy. He has been with the Raymond Concrete Pile Co. since 1925, except for a four-year period of Naval service in World War II. His wartime service included assignments as project manager in charge of all Navy yards, and as director of all continental construction for the Bureau of Yards and Docks. At the time of his retirement from active duty in 1945 he had the rank of rear admiral.

Mr. Smith has represented the Raymond Concrete Pile Co. in South America and as district manager in Washington, D.C., and at present is vice-president. A construction expert, he recently retired as chairman of the Executive Committee of the ASCE Construction Division. As Director, he will serve on the newly formed Joint Cooperative Committee of the ASCE and AGC.

Gordon H. Butler, president and owner of the Polaris Concrete Products Co., Duluth, is a graduate of Purdue University, with early experience in general construction work. He served overseas with the Army Engineers in World War I, and from 1919 to 1928 was general superintendent and vice-president of the Stack Construction Co., Duluth. In the latter year he became president of the Polaris Concrete Products Co.

Called to active duty as major of Engineers in 1941, Mr. Butler was in charge of the construction of a $22,000,000 anhydrous ammonia plant in this country, and later served abroad in both theaters of war. He was discharged in January 1946 with the rank of colonel. Mr. Butler is a past-president of the Duluth Section, the Duluth Engineers Club, and the Minnesota Federated Engineering Societies.

Kirby Smith

Gordon Butler

Bonding Businesses Work with Engineering Groups

THE SURETY ASSOCIATION of America has added a civil engineer to its staff "to act in a liaison capacity with the American Society of Civil Engineers and other engineering groups" as a direct result of suggestions for a program of cooperation between surety bonding companies and the engineering and architectural professions, made by ASCE Executive Secretary William N. Carey in a recent address before the National Association of Surety Bond Producers, reported in the April issue (page 50).

According to the Surety Association, the new employee will be "the eyes and ears of the construction industry in our organization." He will be available for public speaking within engineering and other related groups, and ready to foster cooperation between surety groups and the Society "at all times and on all matters of common interest." The group also states that employment of a civil engineer will be in line with its "program of offering complete facilities to both the surety industry and the public."

The Surety Association of America, made up of 51 member bonding companies and serving 53 others, is both national and international in scope.

JOHN L. SAVAGE, HON. M. ASCE (CENTER), RECEIVES WASHINGTON AWARD from Titus G. Leclair, chairman of Washington Award Commission (left) as Verne O. McClure, president of Western Society of Engineers, looks on, at dinner in Chicago on April 20. For many years chief designing engineer for U.S. Bureau of Reclamation, Mr. Savage was cited for "his unselfish public service devoted to the creation of monumental hydraulic structures utilizing natural resources." Washington Award is joint annual award of Four Founder Societies and Western Society of Engineers for accomplishments preeminently promoting "the happiness, comfort, and well-being of humanity."

Reinstatements and Resignations Listed

WITH DISCONTINUANCE OF the publication of membership applications, additions, and transfers in CIVIL ENGINEERING, by recent action of the ASCE Board of Direction, reinstatements and resignations are being published in "Society News." The current list follows:

Reinstatements

CARTER, OLIVER M., JR., Jun., Engr., Armco Drainage & Metal Products, Inc., P.O. Box 1699, Houston, Tex., reinstated Jan. 1, 1949.

GOERNER, ERNST WILLIAM, Assoc. M., Dr., Care, Alfred Bornemann, 60 Gates Ave., Montclair, N.J., reinstated Jan. 1, 1949.

IRVIN, WILLIAM PAUL, Assoc. M., 1824 Belmont Rd., N.W., Apt. 21, Washington, D.C., reinstated Jan. 1, 1949.

OWENS, REUBEN HIRST, Assoc. M., Senior Engr., Bureau of Engineering, Dept. of Public Works, City Hall, San Francisco (Res., 994 Grizzly Peak Blvd., Berkeley), Calif., reinstated Jan. 1, 1949.

PETERSEN, CLIFFORD, Jun., Vice-Pres., Schakel-Petersen Corp., 845 Via De La Paz, Pacific Palisades, Calif., reinstated Jan. 1, 1949.

STEVENS, MALCOLM S., Jun., Care, Mass. Inst. of Tech., Div. of Industrial Cooperation, Cambridge, Mass., reinstated March 4, 1949.

WILKISON, HARRISON, Assoc. M., Wilkison Concrete Products Co., Dwight, Kans., reinstated Jan. 1, 1949.

Resignations

ALLENSWORTH, WILLIAM BURTON, Jun., Civ. Engr., Pipeline Dept., Creole Petroleum Corp., Las Piedras Estado Falcon, Venezuela, resigned March 17, 1949.

BARNARD, EDWARD MARTIN, Assoc. M., Water Dept., Town Hall (Res., "Penolver" Westwood Row, Tilehurst), Reading, England, resigned Feb. 22, 1949.

BURNHAM, ROGER HARRY, Jun., Safety Engr., Standard Oil Co. of New Jersey, Box 16 (Res., 515 Madison Ave., Apt. C), Elizabeth, N.J., resigned March 4, 1949.

CLARK, ROBERT JOHN, Assoc. M., Clark Equipment Co., Box 989 (Res., 1457 East Cleveland St.), Clearwater, Fla., resigned March 31, 1949.

CLARK, ROBERT TAYLOR, Assoc. M., Office Engr., Carl W. Clark, Archt., 625 James St., Syracuse, N.Y., resigned March 4, 1949.

DE VEUVE, ERNEST ARTHUR, Jun., Engr.-Draftsman, Turner Construction Co., 38 Newbury St., Boston, Mass. (Res., 28 So. Lincoln St., Keene, N.H.), resigned March 3, 1949.

FALKIN, MURRAY, Assoc. M., Struct. Designer, O. H. Ammann Inc., 76 Ninth Ave., New York (Res., 1232 East 28th St., Brooklyn), N.Y., resigned March 28, 1949.

JOHNSON, CARL ROBERT, Jun., Junior Engr., Public Health Dept., City and County, 6th & Cheroke (Res., 1445½ Elm St.), Denver, Colo., resigned March 4, 1949.

PRENDERGAST, JASPER MATTHEW, Assoc. M., Route 1, Box 473A, Saratoga, Calif., resigned March 4, 1949.

STANFIELD, ADRIAN CLYDE, M., Cons. Engrs., Dana, Ill., resigned March 4, 1949.

WHITNEY, WILLIAM JAMES, Jun., Lt. Col., U.S. Air Forces, Hqts. Alaskan Air Command, A.P.O. 942, Care, Postmaster, Seattle, Wash., resigned March 4, 1949.

TOTAL MEMBERSHIP AS OF APRIL 9, 1949

Members	7,301
Associate Members	9,473
Corporate Members	16,774
Honorary Members	42
Juniors	8,578
Affiliates	72
Fellows	1
Total	25,467
(April 9, 1948	25,160)

NEWS OF LOCAL SECTIONS

Coming Events

Cleveland—Dinner meeting, with the Case Institute of Technology Student Chapter providing the program, at Tomlinson Hall, C.I.T., Cleveland, on May 20, at 6:30 p.m.

Kansas—Meeting at Topeka on May 20.

Los Angeles—Regular monthly dinner meeting at the Alexandria Hotel, Los Angeles, May 11, at 6:30 p.m. Preceded by meeting of the Junior Forum.

Maryland—Meeting in the Engineers Club of Baltimore, May 11, at 8 p.m.

Metropolitan—Meeting in the Engineering Societies Building on May 18, at 8 p.m. Junior Branch to meet, May 11 and 25, at 7:30 p.m.

Mid-South—Spring meeting at Vicksburg, Miss., on May 6.

Northwestern—Meeting featuring the annual award of Student Chapter prizes at Coffman Memorial Union, University of Minnesota, May 2, at 6:30 p.m.

Philadelphia—Meeting at the Engineers Club, on May 10 at 7:30 p.m., the program to be presented by Juniors of the Section. Dinner at 6 p.m.

Pittsburgh—Joint meeting with the Constructors' Association of Western Pennsylvania in the Pittsburgh Chamber of Commerce Auditorium, on May 17, at 8 p.m. The Junior Division of the Section is sponsoring a meeting for members of the Student Chapters at the University of Pittsburgh and Carnegie Institute of Technology in the Mellon Institute Auditorium, May 11, at 8 p.m.

Sacramento—Regular luncheon meetings in the Elks Temple, Sacramento, every Tuesday at 12:30 p.m.

San Francisco—Weekly luncheon meetings held in the Engineers' Club of San Francisco on Wednesday.

Seattle—Meeting at the Engineers Club, Seattle, May 25, at 6:15 p.m.

Spokane—Regional conference with engineers from Washington, Oregon,

Montana, and Idaho, meeting at Spokane on May 14. Details from J. Byron Barber, Section secretary, Symons Bldg., Room 422, Spokane 8.

Tennessee Valley—Spring meeting to be held at the General Shelby Hotel, Bristol, Va., on May 20 and 21. Registration begins at 1 p.m. Friday in the hotel with the business meeting of the Section convening at 3 p.m. The dinner dance will be in the ballroom on Friday night. An inspection trip to the Watauga Project is scheduled for Saturday morning, with luncheon to be served in the cafeteria there. Inquiries should be addressed to T. J. Rentenbach (chairman of the Publicity Committee), Rentenbach Engineering Co., 406 West Fifth Avenue, Knoxville, Tenn.

Tri-City—Joint meeting with Reserve Officers Association in the Rock Island Arsenal Cafeteria on May 18; dinner at 6:30 p.m. and meeting at 8 p.m.

Virginia—Joint meeting with Engineers Club of Hampton Roads, Nansemond Hotel, Norfolk, May 13 and 14.

West Virginia—Afternoon meeting at Morgantown, W. Va., on May 13, with reception at 2 p.m. at West Virginia University. A technical session, inspection trip, and dinner dance are scheduled.

Wisconsin—Meeting in the Memorial Union of the University of Wisconsin, May 27, at 6:30 p.m.

Recent Activities

AKRON

AKRON'S PROPOSED SYSTEM of expressways—to consist of a four-lane limited-access route from east to west through the city, roughly following present Route 18 and paralleling existing routes 5 and 8—was described at a recent dinner meeting by Marvin L. Davis, public service director of the city. The plan for the highway, which will be started soon, was developed by the firm of Howard, Needles, Tammen & Bergendoff in conformance with the National Defense System of Highways plan for arterial highway construction. Costs will be shared by the Public Roads Administration, the state of Ohio, and the city on a 50-25-25 basis.

ARIZONA

PROCEDURES AND EQUIPMENT used in canal-lining operations and water distribution were discussed at a recent all-day Section meeting in Yuma by J. P. Collopy, chief of the operations division of the Lower Colorado District of the Bureau of Reclamation. Another principal paper was given by Mulford Winson, Jr., Yuma city engineer, who described the projected modernization of the city's sewer system to meet increased population needs. The afternoon session, held at Algodones, Mexico, featured presentation of a paper on the Morelos Dam, presented by José Velenzuela, engineer for the Mexican Section, and J. F. Friedkin, engineer for the American Section of the International Boundary and Water Commission. A tour of the dam site followed. A dinner dance in the evening, held jointly with the Yuma Cosine Club and Yuma Engineers Club, concluded the program. During the Section's business meeting, the Society's proposed plan for Local Section reorganization was approved.

COLORADO

COOPERATION BETWEEN LOCAL Sections and the ASCE Technical Divisions was recently given impetus by the Colorado Section, which has organized a local Division on Soil Mechanics and Foundation Engineering in conformance with the recommendations of the Committee on Formation of Technical Divisions. Geologist E. B. Waggoner gave a talk on the origin of soils as background material for the group at its first meeting. "New Developments in Western Industry" were discussed at a regular Section meeting by A. M. Riddle, manager of the Market Research and Statistical Department of the Colorado Fuel and Iron Corp. Mr. Riddle said that efforts being made by a number of Western communities to interest manufacturing concerns in locating plants in their localities have, in many cases, had good results. He presented statistics indicating that expansion of more industry westward can be expected.

CONNECTICUT

PREFABRICATED HOUSING WAS discussed at the April dinner meeting of the Section by Edward Graham, New England sales representative for the Lustron Corp. President Frank Ragaini outlined the position of the Board of Direction on the proposed plan for Local Section reorganization.

DAYTON

LONG-TIME STUDIES OF cement performance in concrete were described at a recent meeting by F. R. McMillan, retired director of research for the Portland Cement Association. Mr. McMillan commented, particularly, on investigations of concrete durability, illustrating his talk with slides showing the effect of climatic conditions on specimens made with proper and improper mixes and materials. Since his retirement as director of research, Mr. McMillan has served the association in a consulting capacity.

DULUTH

THE STEEP ROCK Mine in Ontario which has many unusual features, was discussed by W. H. Crago, a mining engineer, in the feature talk at a recent luncheon meeting. During the business session, the Section made a motion to support Gordon Butler for ASCE Director from District 7.

INDIANA

FORMER SOCIETY VICE-PRESIDENT Ralph B. Wiley explained the proposed ASCE plan for redistricting and a proposal for reorganizing technical publications at a recent meeting. Following discussion of the subject, the Section unanimously passed a motion favoring retention of the existing system of Districts and Zones. A film, "Treasures from the Sea," was shown through the courtesy of the Dow Chemical Co.

INTERMOUNTAIN

POLLUTION PROBLEMS IN Utah were detailed by Lynn Thatcher, state sanitary engineer, in the feature talk of the evening at a joint meeting with the Ogden Engineers Club. Protection of the state's water supplies was then discussed by Clifford N. Stutz, assistant state sanitary engineer. A third talk—on the history of the U.S. Forest Service—was given by Henry M. Shank, chief engineer for the Service in the region.

KANSAS

MANY KANSAS COMMUNITIES have to contend with the dangers of a high nitrate content in their drinking water, Dwight F. Metzler, chief engineer and director of the Division of Sanitation of the Kansas State Board of Health, told members of the Section at a joint dinner meeting with the Salina Engineers Club. Speaking on the state's sanitation needs in 1949, Mr. Metzler discussed the cost of new construction for adequate water supply and sewage disposal and warned of the growing problem of industrial waste disposal. He said that the Board of Health, which is engaged in comprehensive surveys of the pollution problem in the major river basins of the state, has recommended and, in extreme cases, compelled cities to construct treatment plants.

KANSAS CITY

PROBLEMS OF PERSONNEL administration were covered at a recent meeting by Rex M. Whitton, engineer of maintenance for the Missouri State Highway Department. To arrive at a fair means of determining wages and salaries, he said, the Department has adopted a point system for evaluating the various phases of the work and employee fitness to do the work. However, he emphasized the

fact that any system of job evaluation and salary fixing must constantly be adjusted to normal changes, and that no absolute rule can be applied.

KENTUCKY

PENDING NATIONAL LABOR legislation as it affects professional employees was discussed at a recent dinner meeting by ASCE Director Daniel V. Terrel, who pointed out the desirability of professional groups making their positions known to their representatives in Congress. During the business meeting, the Section voted to invite the Society to hold a Spring or Fall Meeting in Louisville as soon as a meeting date is open. The technical program consisted of the showing of a Highway Research Board film on pilot studies of the operation, characteristics, economics, load-economics relationship, and road design influence on the Pennsylvania Turnpike and old U.S. Highway 30.

LEHIGH VALLEY

FUTURE DEVELOPMENTS IN welded steel building were outlined by Arsham Amirikian, head designing engineer for the Navy Bureau of Yards and Docks, at a joint meeting with the American Welding Society on April 4. Illustrating his talk with slides, Mr. Amirikian told of the savings permitted by designing shapes, which will give minimum waste and can be used for both buildings and floating structures. He also listed the results of Navy investigations in the field of welded structures.

MARYLAND

THE GEOGRAPHY AND trade of Canada in their effect on our economy were described by Comdr. Charles G. Gold, staff member of the Army-Navy Industrial College, in a talk on "Canada, Greenland, and the Arctic Regions" that featured a recent dinner meeting. Commander Gold stated that Canada, with a prewar trade of $3,000,000,000 ranks first in the world production of radium, platinum, and nickel, and second in the mining of gold. Greenland and Alaska are important to us as sources of weather data and because of their strategic location, rather than for their resources, he said.

METROPOLITAN

DESIGN AND CONSTRUCTION of the $77,000,000 Brooklyn-Battery Tunnel, which will connect Manhattan and Brooklyn under the East River, were discussed at the April meeting of the Section by Ralph Smillie, chief engineer of the Triborough Bridge and Tunnel Authority. Mr. Smillie also brought out interesting features concerning the ventilating buildings and approaches. The 9,117-ft tunnel, longest in the United States, will have four 24-ft 4-in. lanes, making possible the trip between Battery Park in Manhattan and the Red Hook section of Brooklyn in three and a half minutes.

MONTANA

PLANS FOR FINANCING urgently needed street, water supply, and sewage disposal improvements for the City of Helena were reviewed at a recent Section meeting in Helena by a panel of engineers on the municipal staff. The speakers—Public Safety Commissioner Hugh Potter, Street Commissioner Thomas Finnegan, and City Engineer W. H. Butler—brought out the fact that improvements to the water-distribution system, which has been badly damaged by the past severe winter, are imperative. Essential repairs, according to Mr. Butler, will involve the replacement of more than 50,000 ft of waterpipe and of a number of street mains. In a summary of the situation, President Morrison stated that expenditure of $4,535,000, including the cost of constructing a new outfall sewer and disposal plant, will be needed to put the city's physical plant into first-class condition.

LOS ANGELES SECTION

PROBLEMS INVOLVED IN the first commercial installation of the Fido fog dispersal system at the Los Angeles Airport were discussed at a recent Section meeting by M. T. Tucker, city airport manager. Technical phases of the project were presented by John K. Minasian, Los Angeles engineer, who stated that a surprising amount of engineering is required in the installation to produce the desired results. A brief description of the Los Angeles Airport installation appears on page 70. A paper on the $45,000,000 Owens River Gorge hydroelectric project, given by James Laughlin, assistant engineer of design and construction for the Los Angeles Water Department, concluded the technical program. This project will involve construction of a long aqueduct system, three power plants, and 250 miles of transmission line. During the business session, ASCE Director Julian Hinds summarized the proposed Society plan for reorganization of Districts and Zones.

Mechanical principles embodied in the design and use of artificial limbs were described at the monthly meeting of the Junior Forum, held prior to the regular Section meeting, by Dr. Craig Taylor, associate professor of engineering at the University of California. His talk was entitled "Developments in Prosthetics."

BOARD OF DIRECTION OF LOS ANGELES SECTION FOR 1949, pictured in recent session, consists of (left to right) Julian Hinds, ASCE Director from District 11; Robert J. Kadow, treasurer; Charles R. Compton, past-president (1947); Homer W. Jorgenson, secretary; D. Lee Narver, president of Section; Ray L. Derby, past-president (1948); R. R. Shoemaker and Sterling Green, vice-presidents; and Stanley Butler, president of Junior Forum.

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NASHVILLE

AN ARMY CORPS of Engineers plan for comprehensive development of the Cumberland River basin was explained by Col. Howard V. Canan, district engineer for the Corps, at a recent meeting. Colonel Canan stated that several of the six flood-control reservoirs, authorized for construction in the basin, are completed and have already proved effective in lessening the annual floods in the area. The plan also provides for improvement of navigation by construction of three modern navigation locks on the Lower Cumberland to supplement the 15 outmoded, manually operated locks on the main stream that provide 6-ft navigation depth between the mouth of the river and the head of Pool No. 8. According to Colonel Canan, traffic on the Cumberland reached an all-time high in 1947 of approximately 1,280,000 tons, despite the inadequacy of the present lock system.

PHILADELPHIA

THE ST. LAWRENCE Seaway and Power Project was described by Frank P. Fifer at a joint meeting with the Engineers' Club of Trenton, held in Philadelphia on April 12. A consulting engineer for the North Atlantic Division of the Corps of Engineers, Mr. Fifer formerly served the Corps as head engineer on the long-pending and much-discussed St. Lawrence Seaway and Power Project.

PITTSBURGH

PROGRESS MADE BY the City of Pittsburgh in the field of smoke prevention since enactment of a city ordinance aimed at control of the problem was detailed by David Kuhn, of the Bureau of Smoke Prevention, at a recent joint meeting with the Civil Section of the Engineers' Society of Western Pennsylvania. Thomas Wertz, Allegheny County engineer, then discussed the plans of Allegheny County in the field and described the county ordinance that is to be enacted.

PROVIDENCE

NEW DEVELOPMENTS IN the design and construction of steel structures were outlined at a recent meeting of the Providence Section by Jack Singleton, chief engineer of the American Institute of Steel Construction, New York City. Of particular interest to the group was his discussion of the use of vermiculite as an aggregate in insulation and in construction of light-weight floors. Mr. Singleton also recounted his experiences in the design and testing of bridges while in the Army.

SACRAMENTO

EFFORTS BEING MADE by the City of Sacramento to relieve traffic congestion in the downtown area were recounted by D. J. Faustman, city traffic engineer, at a recent luncheon meeting of the Section. These measures include traffic counts and studies to determine vehicular speeds and other relevant factors. At another recent luncheon meeting, Clyde C. Kennedy, San Francisco consultant, spoke on the problem of sewage and industrial waste treatment in the city and described a proposed solution to the problem.

NEW MEXICO

METHODS OF TRACING the trajectory of guided missiles were described by Ben Billups, of the White Sands Proving Grounds, at a recent meeting at Las Cruces, N.Mex. According to Mr. Billups, radar tracking of the missiles is only approximate, so it was necessary to develop a more accurate method. The meeting was conducted by the New Mexico A. & M. College. At another recent meeting of the two groups, student papers were screened in a preliminary competition to select participants in the Student Chapter Conference at Oklahoma City. The Section voted to contribute to the traveling expenses of the two winning candidates from A. & M. College and the University of New Mexico.

NORTHWESTERN

PRESENT-DAY PLANNING for industrial mobilization and its effect on individuals and corporations was the subject of the feature talk at a recent Section meeting. This was presented by Charles A. Leonard, chief of the St. Louis Procurement Office of the Army Corps of Engineers, who led a discussion on the subject at the conclusion of his talk.

In keeping with the Junior Forum's new policy of having a member speak at each meeting, Cole Samuelson described his work as sanitary engineer for the Minnesota State Board of Health at a recent meeting of the group. The guest speaker for the occasion was C. M. Bach, chemical engineer and bacteriologist for the Minneapolis Water Department, who gave an illustrated talk on treatment of the Minneapolis water supply.

OKLAHOMA

POLITICAL SUBDIVISIONS HAVE no effect on insects or animals, James P. Slater, chief public health engineer of Tulsa, told members of the Tulsa Branch at a recent meeting. As an aid in the maintenance of health standards, Mr. Slater urged the formation of a joint city-county health department for the Tulsa area. He also stated that a professor from the University of Oklahoma now makes regular trips by air from Norman to Tulsa for the purpose of conducting classes for inspectors of the Tulsa Health Department. At the conclusion of his talk, Joseph Perry and Elliott Glass, Section Juniors, discussed Society activities and publications.

ST. LOUIS

A COMPREHENSIVE MAPPING program has a pronounced influence on community development, according to E. R. Swanson, president of the Continental Aerial Surveys, Inc., St. Louis, and wartime chief of the Aeronautical Chart Service, which provided maps and charts for the Air Force. Speaking on "Aero-Maps for Business and Industry" at a recent meeting, Mr. Swanson emphasized the benefits to be derived by business and civic groups and local government bodies from adequate maps of their communities, and discussed the equipment and techniques required for accurate mapping. He holds patents on the Aerostereograph and the Autoratiograph, mechanically controlled optical instruments especially designed to produce composite aerial photographic maps for city and regional planning purposes.

TENNESSEE VALLEY

PROPOSED REVISIONS OF the Chattanooga zoning ordinance were covered by R. S. Lillard, engineer-secretary of the Hamilton County Planning Commission, at a recent meeting of the Chattanooga Sub-Section. The extended discussion following his talk included the allied subject of off-street parking.

The Tennessee Valley Section reestablished its Muscle Shoals Sub-Section at a recent organizational meeting in Sheffield, Ala. Officers of the group are Jack R. Rountree, president, and Vernon P. Crockett, secretary-treasurer.

TOLEDO

HISTORY, FILTRATION, DISTRIBUTION, and other aspects of Toledo's Lake Erie water system were discussed at a recent Section dinner meeting by George Van Dorp, commissioner of water for the city. Mr. Van Dorp presented interesting comparisons between Toledo's water rate and other commodities. The Section will sponsor the April issue of *Toledo Technical Topics*.

TRI-CITY

VARIOUS PHASES OF structural steel construction were described by Jack Singleton, chief engineer of the American Institute of Steel Construction, New York City, at a joint dinner meeting with the Tri-City section of the ASME, held at the Rock Island Arsenal. Mr. Singleton's talk covered the newer types of fireproofing media (such as vermiculite), rigid and semirigid joints, lightweight floors, and an analysis of building code and specification requirements. The meeting set an all-time attendance record since the formation of the Section in 1940 with an attendance of 131.

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NEWS BRIEFS

Rise in Construction Activity in First Two Months of 1949 Reported

DESPITE CHARACTERISTIC SEASONAL drops in some phases of construction, all new construction activity for the first two months of 1949 amounted to $2.4 billion, 11 percent above the total for the corresponding period of 1948, according to a recent Department of Commerce Industry Report. Private construction, totaling $1,863 million, constituted more than three-quarters of the total dollar volume put in place and was 4 percent above that for the first two months of 1948. New public construction totaled $544 million during the first two months of 1949, 43 percent above the figure for the corresponding period a year ago.

The value of new construction put in place in February totaled $1,146 million, a seasonal decline of 9 percent from January, but 14 percent above the figure for February 1948. Privately financed new construction, accounting for three-quarters of the February total, was valued at $889 million. Public construction for the month was valued at $257 million, a decrease of nearly 11 percent from January.

Some 46,000 new permanent non-farm housing units were put under construction in February, according to preliminary estimates of the Bureau of Labor Statistics. With 50,000 units reported as having been started in January, new housing is now about 6,000 units behind the first two months of last year. This drop the Bureau attributes in part to the extremely severe winter in some sections of the country early in the year. According to the Bureau, however, most sections of the country and a majority of the larger cities show recent increases in the number of home-building permits issued—usually a sign of increased new home-building activity.

Construction costs in January dipped very slightly (0.1 of 1 percent) below the December level, according to the Department of Commerce Composite Index of Construction Costs. Despite this decline (the fourth successive minor drop from a September high of 217.2), average construction costs in January were 5.6 percent above those in January 1948.

Countering this dip in January construction costs, average wholesale prices of construction materials showed an increase of slightly less than 0.1 of 1 percent during the month, according to indexes compiled by the Bureau of Labor Statistics. This rise halted a three-month downward movement in the Bureau's Index of Wholesale Prices of Construction Materials—a down trend roughly paralleling the recent dip in construction cost levels.

On an over-all basis, building materials production in January dropped 12 percent below December levels, a sharper decline than the normal seasonal drop usually encountered between these two months. The January Index reading of 117.3 (1939 monthly average—100) was the lowest since March 1946. Production gains recorded for wire nails, concrete reinforcing bars, range boilers, and gypsum lath were offset by the decreases recorded in the month's production totals for such major items as lumber, brick, cement, and for most wall, roof, plumbing, and heating materials.

Construction bids are dropping faster than the drop in costs would warrant because of a considerable drop in contingencies and intangible construction costs not reflected by cost indexes.

President's Highway Safety Conference Called by Truman

TO ASSESS THE accomplishments of the Action Program, initiated at the 1946 President's Highway Safety Conference and to devise further applications of the program will be the principal objectives of the Second Highway Safety Conference, to be held in Washington, D.C., June 1–3.

In calling the conference, President Truman said, "Even though this year's continued progress indicates we have reached an all-time low death rate, we must face the fact that not all has been done that can be done and that the Action Program has not been put to full use in many of our states and cities. It points to a need for another full-scale conference as recommended by the Committee on Conference Reports."

Though 1948 marks the second successive year in which traffic deaths dropped below the figures for the previous years, the conference committee in a meeting prospectus warns against complacency. For example, it states that "traffic fatalities for October 1948 exceeded those of October 1947 by 8 percent. State fatality rates in 1948 ranged from less than 3 to almost 12 per hundred million vehicle miles of travel. In the cities and towns the rate varied from less than 3 to almost 20 fatalities per 10,000 registered vehicles."

The committee points out that, while 1.7 fewer persons were killed in cities in 1948 than in 1947, 6 percent more persons were killed in rural areas. There is much additional evidence, the committee states, "to substantiate the theory that efforts of the 1949 conference must be centered upon a drive to reduce traffic-death frequency in the small cities and rural areas." Serious, too, is the fact that as many children, teen agers, and young adults were killed in traffic accidents last year as in the year before, the entire reduction in motor-vehicle deaths occurring among persons 25 years of age and over.

By request of the President, Maj. Gen. Philip B. Fleming, M. ASCE, Federal Works Administrator, is again serving as general chairman of the conference. Chairmen named to head each of the subcommittees in charge of arrangements are Roy W. Crum, ASCE Director, General Aspects; H. E. Hilts, Assoc. M. ASCE, The Highway; B. B. Bachman, The Vehicle; and Harry E. Neal, Operation.

Further information on the conference may be obtained by writing to the President's Highway Safety Conference, Federal Works Building, Washington 25, D.C.

Steel Output in First Quarter Sets New Record

THE GREATEST PRODUCTION of raw steel in history was achieved by the industry in the first quarter of the year, according to a recent release of the American Iron and Steel Institute. At the same time, the Institute said, the output for March was greater than for any previous month. The record first-quarter yield of 24,053,181 tons of steel exceeded by more than 2,000,000 tons the output for the first quarter of 1948, and by 506,972 tons production in the fourth quarter of 1948, the previous record period. This first-quarter output raised the total production of raw steel in twelve successive months to more than 90,000,000 tons, an achievement never before equaled in a like period.

For the first time in any three-month period, steel-making furnaces were operated at over 100 percent of theoretical capacity in the first quarter, with an estimated average of 101.5 percent.

The record March production of 8,388,963 tons exceeded the output of the previous peak month of January by more than 200,000 tons, and the March 1948 output by 780,000 tons. During the month the furnaces were operated at 102.7 percent of capacity, the highest percent of rated capacity for any month.

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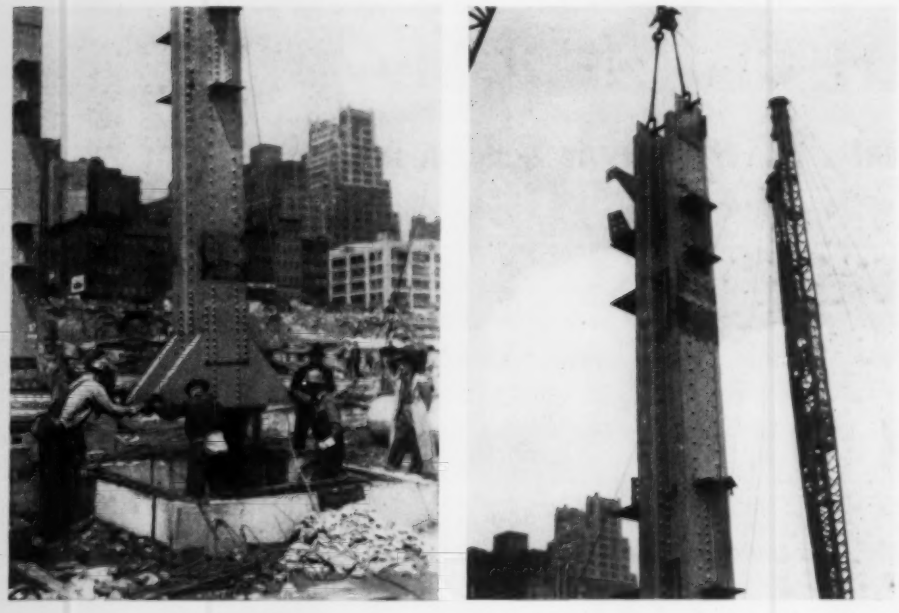
Steel Erection Starts for U.N. Secretariat Building



FIRST COLUMNS ARE RAISED in start of steel construction for 42-story Secretariat Building, first unit in United Nations permanent headquarters on East River in mid-town Manhattan. In view at left, workmen steady 24-ft 16-ton steel column, which is being lowered into position on sunken concrete piers reaching to bedrock. Right-hand photo shows column following erection by stiffleg derrick. Some of largest wind-bracing connections ever developed will be required to fortify steel framework because of narrowness of building (72 ft wide and 287 ft long). More than 13,000 tons of steel will be used in building. Framework is scheduled for completion by September, and building ready for occupancy by late 1950.

Anti-Pollution Action Taken by Ohio Water Commission

TAKING ITS FIRST ACTION to establish sewage-treatment requirements on interstate waters, the newly created Ohio River Valley Water Sanitation Commission has made recommendations for "substantially complete removal of settleable solids and 65 percent reduction of biochemical oxygen demand" in organic wastes discharged into the Cincinnati Pool during periods of low flow. The pool, a 22-mile stretch of the Ohio River between navigation dams 36 and 37, receives waste from Cincinnati and several northern Kentucky communities and, also, serves as a source of water supply for these cities.

Despite the fact that these recommendations are higher than the minimum of 45 percent removal of total suspended solids (about 35 percent b.o.d. reduction) stipulated in the eight-state compact under which the commission functions, municipal officials have expressed themselves as unanimously in favor of the requirements. This, the Commission states, is an indication of growing public sentiment in favor of stream-pollution abatement in the area.

Chairman of the committee that determined the standards was B. A. Poole, M. ASCE, technical secretary of the Indiana Stream Pollution Control Board. Other members were F. C. Dugan, M. ASCE, director, Division of Sanitary Engineering, Kentucky Department of Health; F. H. Waring, M. ASCE, chief engineer, Division of Sanitary Engineering, Ohio Department of Health; John H. Wiseman, Ohio River Division of the Army Corps of Engineers; and M. LeBosquet, Jr., senior sanitary engineer for the U.S. Public Health Service.

Fog Dispeller Tested at Los Angeles Airport

SUCCESSFUL COMPLETION OF first tests of the $842,000 thermal fog-dispersal system being installed at the Los Angeles Airport was recently announced by Col. Clarence M. Young, general manager of the city's Department of Airports, and James E. Read, acting regional administrator of the Civil Aeronautics Administration. Termed the "Fido System," the device consists of jet-atomizer nozzles paralleling both sides of the runway for 4,000 ft and then fanning out for 2,000 ft into the approach zone. Each burner protrudes 14 in. above the ground and shoots flames from 9 to 10 ft into the air. The intense heat generated raises the saturation point of the atmosphere to absorb water vapor and dispel fog.

The principle of Fido operation, developed by the British during the war, is credited with safely landing 2,486 aircraft in dense fog. It was further developed in 1944 by the U.S. Navy in Alaska and in recent experiments at Landing Aids Experiment Station, Arcata, Calif., jointly supported by the CAA, the Air Force, and Navy.

U. S. Engineers Authorized to Make Alaskan Survey

A COMPREHENSIVE SURVEY of the territory of Alaska has been authorized by the Chief of Engineers and will be carried out by the Alaska and Seattle districts under supervision of the North Pacific Division, according to a recent announcement by Col. Theron D. Weaver, division engineer. Designed to accomplish in Alaska what has been done by the Corps of Engineers in various river basins of the United States, the projected survey will cover the entire territory, resulting in a coordinated plan for development of its water resources.

Completion of the report may require several years, because of the inaccessibility of many areas and climatic restrictions on work, Colonel Weaver stated. Studies will be undertaken progressively by subareas, with each study complete in itself but forming a coordinated part of the survey for the entire region. Such areas as Fairbanks, Anchorage, and Juneau, which because of rapidly increasing population and possible industrial expansion have problems warranting early study, will be surveyed first.

Pointing out that since the beginning of the war the Corps of Engineers has carried out an extensive program of military construction in Alaska, Colonel Weaver stated that more than $100,000,000 has been expended since June 1946 for improved air and ground facilities at Fort Richardson, near Anchorage and at Ladd and Eielson Fields near Fairbanks. A new dock and warehouses have been built at Whittier, a terminal of the Alaska Railroad. The famous "Canol" pipeline, constructed by the Corps of Engineers during the war, is still operated by the Corps for the purpose of supplying diesel oil to the Fairbanks area by way of Skagway-Whitehorse.

Although Alaska covers an area of 586,000 sq. miles—larger than Oregon, Washington, Idaho, Montana, Wyoming and Utah combined—it has a population of less than 100,000. However, growth of the region has been greatly accelerated since the war by both civil and military development, Colonel Weaver said.

India to Have Large New Power Project

A CONTRACT FOR the design and equipment of a 110,000-kva hydroelectric power project on the Sutlej River in the East Punjab province of India has been awarded by the Indian government to the Westinghouse Electric International Co. The largest development undertaken since the new Indian government was formed, the project will consist of two major waterwheel turbine-generator installations, designated Nangal I and Nangal II, six miles apart. Each installation will have two 33,500-hp turbines, operating from a 98-ft head of water and using more than 3,000 cfs.

About three years will be required for manufacturing the equipment, with Nangal I apparatus scheduled for shipment in two years. Cost of the equipment will be approximately $9,000,000.

How to make cement *taste better*

In his *Mechanic Exercises or the Doctrine of Handy-works* published in 1678, Joseph Maxon recommended this mix: "Take ½ a Pound of Old Cheshire-Cheese, put to it about a Pint of Cows-Milk, let it stand all Night, the next Morning, get the Whites of 12 or 14 Eggs, then take ½ a Pound of the best Unslackt or Quick Lime that you can get, then sift it through a fine Hair Sieve into a Bole of Wood, to which put the Cheese and Milk, then add the Whites of Eggs".

There's a better way of making cement today . . . and a better way of building the forms today's concrete goes into . . . the "Richmond Way". Here's how the "Richmond Way" will work for you:

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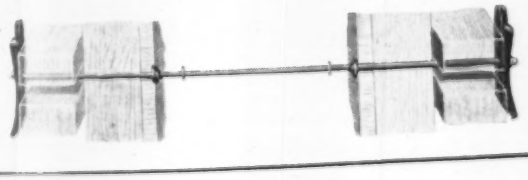

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Highway Protection Held Vital at Planning Conference

NOT ONLY DO roadside businesses detract from the appearance of our highways and give disgraceful looking approaches to most of our cities, they also have a depressing effect on traffic and increase accident hazards, Joseph Barnett, M. ASCE, chief of the Urban Road Division of the Public Roads Administration, told the recent National Citizens Conference on Community Planning, held at Oklahoma City.

"The protection of arterial highways and avoidance of obsolescence are best accomplished by authority to control access," Mr. Barnett stated. Urging adequate state legislation for zoning, roadside use, and setbacks, he pointed out that state highway departments would then need to acquire initially only sufficient width of property to construct highways. "Later, when widening becomes necessary," he said, "the departments would be able to acquire additional width from private owners with assurance that the cost will increase in relation to land values and not be prohibitive because of extensive business construction along the original highway."

In another leading talk, presented at the four-day conference, Maj. Gen. Philip B. Fleming, M. ASCE, Federal Works Administrator, urged the planning of a reserve shelf of state and local public works in case "private construction should falter in the months ahead." An adequate reserve of projects, planned and ready, cannot be produced as the need arises, he warned.

Maj. Gen. U.S. Grant III, M. ASCE, president of the American Planning and Civic Association, which conducted the conference, emphasized the fact that "planning means profits, progress and public benefits." Other sponsoring organizations were the Oklahoma City Planning Commission, the Oklahoma City Citizens' Planning Association, the Oklahoma Planning and Resources Board, and the Chamber of Commerce.

Army Sets $55,000,000 for New York District in 1949

EXPENDITURE OF $55,000,000 for construction of veterans' hospitals and improvement of harbors and waterways in the New York District of the Corps of Engineers in 1949, has been announced in a recent release from Col. W. W. Wanamaker, M. ASCE, district engineer. Colonel Wanamaker, stated that this is a substantial increase over the 1948 appropriation of $42,000,000 for the New York District.

Channel dredging and harbor improvement will constitute an important part of the work, since the New York District supervises 700 miles of waterways. At present, Weehawken Channel in the Hudson River is being deepened by removal of silt by suction dredge at the rate of 6,500 tons per 70-min operation.

The five veterans' hospitals under construction in the New York District include the $22,400,000 Franklin Delano Roosevelt Hospital, which will provide 1,984 beds, and the $18,000,000 Albany Hospital.

Member Represents United States at Cairo Congress

T. W. MERMEL, ASSOC. M. ASCE, was appointed by the State Department to represent the government at the recent Second International Technical Congress in Cairo, Egypt. Mr. Mermel is assistant to the Commissioner of Reclamation, stationed in Washington, D.C.

Rational utilization of industrial raw materials throughout the world was the over-all theme of the congress. Water and its use in the Middle East came in for discussion. Three engineers from the United States delivered papers during the six-day conference.

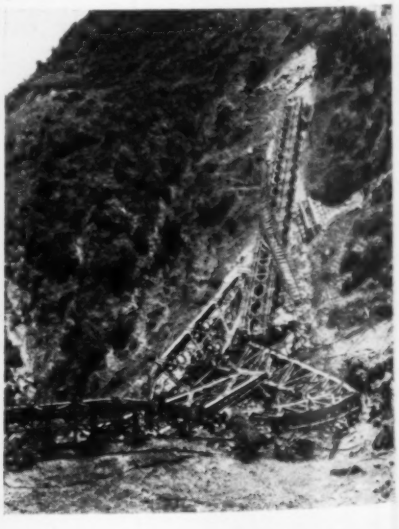
Destroyed Greek Facilities Restored by American Engineers

PROGRESS IS BEING MADE in the restoration of Greek transport and harbor facilities by the American Mission for Aid to Greece and the Army Corps of Engineers, aided by private contractors, has been reported by Knute A. Johnston, Army engineer, who served for a year as chief inspector on the work.

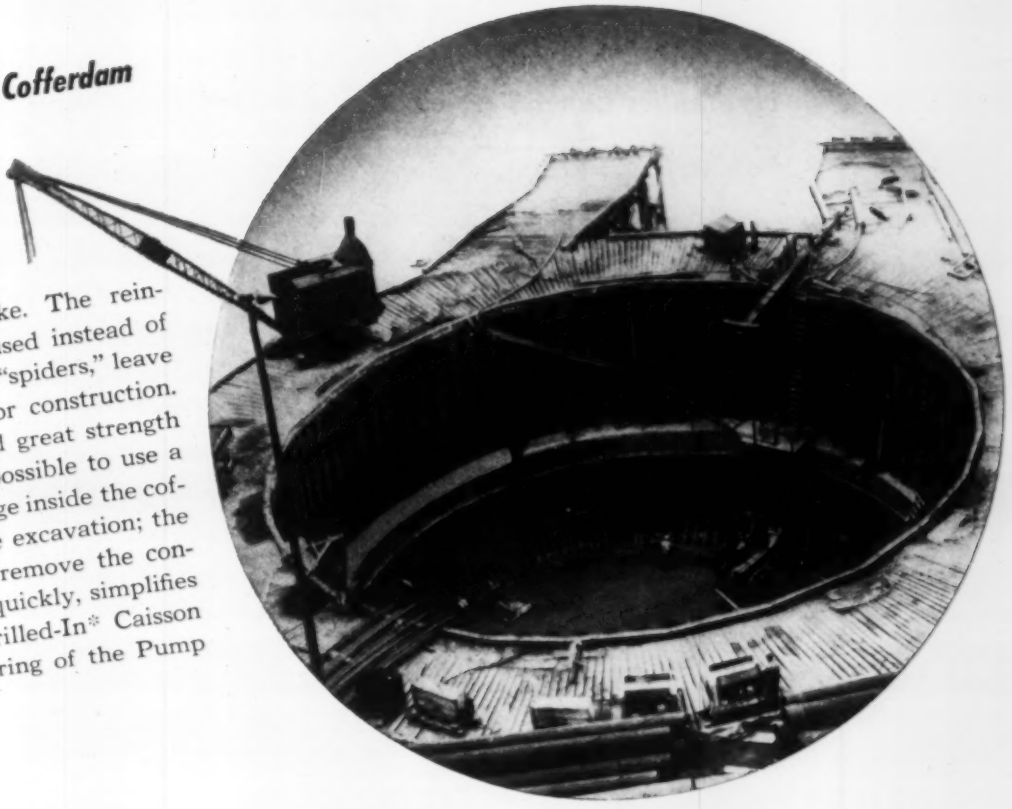
Among completed facilities are several hundred miles of paved highways, including a 40-mile roadway from Athens to Corinth, drydocks in the Piraeus Harbor and at Piraeus, and the breakwater and docks at Salonika. According to Mr. Johnston, the Nazis wrecked about half of the railroad system as they retreated—bridges, tracks and installations—and destroyed most of the rolling stock. New track has been laid on a new roadbed, he said, and new shop equipment installed. The speedy restoration to service of the 6,400-ft-long Corinth Canal, described in the April issue (page 64), by the Army Corps of Engineers and the New York contracting firm of Steers-Grove, was one of the major undertakings. This project also involved reconstruction of two bridges—one for highway and one for railroad traffic.

Completion of plans for an irrigation system that will supply water to all the farmland from Athens through Salonika and Macedonia has also been reported by Mr. Johnston, who says that construction of the system will go ahead under the provisions of the European Recovery Program. Other projects planned or under way, he stated, include the establishment of complete hospital facilities in Athens under the U.S. Public Health Service, and the shipment of farm equipment and livestock, to replace wartime losses, through the cooperation of the U.S. Department of Agriculture.

ASOPOS BRIDGE ON MACEDONIAN RAILROAD (photo, right), demolished by guerillas during war in Greece, has since been reconstructed by American Mission to Greece and Corps of Engineers, under direction of Col. D. W. Griffith and supervision of late R. A. Radford, M. ASCE, and Knute A. Johnston. Reconstruction of Gorgopotamos Bridge (lower view) destroyed in guerilla warfare, was handled by Steers-Grove, New York contractors.



Concrete Ring Wales in Cofferdam



Union Electric Power Co., Venice, Ill. The 100 ft. dia. cofferdam in the Mississippi River facilitates construction of the Circulating Water Intake. The reinforced concrete wales, used instead of usual cross bracing and "spiders," leave the entire area open for construction. In addition, they afford great strength and economy. It was possible to use a floating hydraulic dredge inside the cofferdam for most of the excavation; the ability to install and remove the construction equipment quickly, simplifies installation of the Drilled-In* Caisson foundations and pouring of the Pump Well Structure.

Driven Core Composite Pile

St. George Ferry Terminal, New York City. This high capacity pile can be driven to depths of more than 50 ft. and will support exceptionally heavy loads. The steel H-Beam core is driven through the concrete filled shell to practical refusal. On this job an 8 in. H-Beam was used inside a 16 in. diameter shell. A test load of 216 tons on a single Driven-Core Composite Pile, with an 8 in. 40 lb. wide-flange beam, showed a total settlement of less than ½ in. and a recovery with load removed, to 3/16 in. Design load was 80 tons.

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Hydraulics Experts Meet at Waterways Experiment Station

CORPS OF ENGINEERS COMMITTEE ON TIDAL HYDRAULICS holds two-day conference at Waterways Experiment Station in Vicksburg. Shown in front row, left to right, are Richard O. Eaton, M. ASCE, South Pacific Division, Oakland, Calif.; Oscar Rosenzweig and Clarence F. Wicker, Assoc. M. ASCE (committee chairman), Philadelphia District; and Joseph B. Tiffany, Jr., M. ASCE, recorder, Waterways Experiment Station. In back row are: Martin A. Mason, Assoc. M. ASCE, Beach Erosion Board, Washington, D.C.; Berkeley Blackman, South Atlantic Division, Atlanta, Ga.; James R. Johnston, North Atlantic Division, New York, N.Y.; and Ralph F. Rhodes, M. ASCE, Savannah District, Savannah, Ga. Activities of committee include not only tidal hydraulics, but related processes contributing directly to channel shoaling.

Parallel Bay Crossing Approved by California

IMMEDIATE CONSTRUCTION OF a second San Francisco Bay crossing paralleling the existing San Francisco–Oakland Bay Bridge, and construction of a southern crossing as soon as financing is possible, have been unanimously approved by the five-man California Toll Bridge Authority, which has been studying the problem for the past three years. One of the major engineering problems involved in the project will be sinking the piers through water, mud, and muck to bedrock, in places as much as 240 ft below the water surface.

Reasons influencing the decision of the Authority to give priority to the parallel span include the fact that it will afford greater relief to the present bridge, be cheaper to build and maintain, and that earlier completion (probably by 1954) will be possible. Since traffic will be one way on each of the parallel bridges, the projected parallel span is also expected to afford greater safety.

Articles on the proposed bay crossings were published in the August 1948 issue of CIVIL ENGINEERING (page 504) and on page 23 of the January 1949 issue.

Annual Award to Be Given for Advances in Concrete

ESTABLISHMENT OF AN annual cash award of $500 for notable contribution to the advancement of reinforced concrete construction has been announced by the Concrete Reinforcing Steel Institute. Contributions may be in the field of research, design, or construction, the first award to be made at the 25th anniversary meeting of the Institute at White Sulphur Springs, W. Va., July 14–16. The recipient of the first award will be invited to attend the meeting as guest of the Institute.

Engineers wishing to submit material for consideration should communicate with Harry Delzell, secretary to the Award Committee, Concrete Reinforcing Steel Institute, 38 South Dearborn Street, Chicago 3, Ill.

States Exhaust Federal Funds for Road Building

VIRTUALLY ALL OF the federal-aid funds provided under the 1944 postwar Federal Aid Act have been expended on new roads, according to Col. E. R. Needles, M. ASCE, president of the American Road Builders' Association. In a recent ARBA release, Colonel Needles stated that, out of a total authorization of $1,500,000,000, the sum of $1,425,394,287 has been expended for new highway construction completed or in the process of completion. "This figure," he said, "indicates that the states have matched the federal funds, as required under the act. They have done so in the face of higher costs and shortages of materials and labor because of the tremendous demand for new roads.

"The trend for highway construction has continued upward," he pointed out. "The awards during the 1948 fiscal year amounted to $1,058,927,000 as compared to $817,742,000 awards by the state highway departments in the preceding year. Necessity for better highways will probably keep construction activity at a high level for the next few years."

Colonel Needles estimated that it will take $60,000,000,000 and from 15 to 20 years to get our highways in shape to handle present and future traffic demands. "Federal aid must be authorized at the rate of $1,000,000,000 annually to meet this estimate," he said.

Capacity of World's Largest Shovel Increased

INSTALLATION OF NEW 45-CU YD MARION DIPPER on Marion 5561 shovel, owned by Hanna Coal Co., increases capacity of shovel 5 cu yd in joint experiment in Ohio coal-stripping fields to determine "economic ultimate" of modified armor plate steel in power shovel dipper design and construction. Successful outcome of experiment will add 5-cu yd capacity, equivalent of average size dump-truck load, to each one-min digging cycle of Marion shovel.

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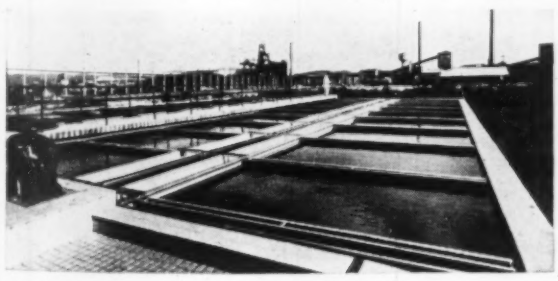

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Construction Projects Announced by U.S.B.R.

WORK IN PROSPECT on several Western and Pacific Coast construction projects is listed under the head of "Bid Calls Expected This Month" in the Bureau of Reclamation's *Advance Construction Bulletin*, dated April 1. Though the information given is subject to revision, these data will provide an indication of the size, nature, and location of proposed projects.

TRANSMISSION LINES
Colorado-Big Thompson Project, Colorado

Location: From Estes Park Power Plant to Granby Pumping Plant near Granby, Colo.

Work: Construction of the Estes Park-Marys Lake and Estes Park-Granby Pumping Plant transmission lines. Alternate specifications are to be issued for: (1) 34 miles of wood pole, and 6.5 miles of steel-tower 115-kv transmission line; or (2) 4 miles of wood-pole 69-kv line, 1 mile of steel-tower double-circuit line with 115-kv and 69-kv circuits, 1 mile of 115-kv steel-tower double-circuit line, and 13 miles of 69-kv submarine cable through Adams Tunnel.

Time Allowed for Completion: Estes Park-Marys Lake—300 days; Estes Park-Granby—450 days; cable through Adams Tunnel—May 1, 1950.

COURTLAND CANAL
Missouri River Basin Project, Nebraska

Location: Near Superior, Nebr.

Work: Construction of earthwork and structures for about 16 miles of Courtland Canal, 750 cfs capacity.

Excavation for canal	1,194,000 cu yd
Excavation for structures and wasteways	97,570 cu yd
Concrete	8,040 cu yd
Furnishing and placing reinforcing steel	1,189,000 lb
Furnishing and laying 18- to 54-in. diameter precast concrete pipe	550 ft
Furnishing and placing timber in structures	400 Mbm

Time Allowed for Completion: 750 days

R. Robinson Rowe, M. ASCE

IT DIDN'T LOOK as if Professor Neare would get up to bat at the May meeting of the Engineers Club, because of the row over reapportionment. The east-side delegates had proposed dividing the 19 precincts into 7 wards, both sides wanted the odd ward, and the west-side delegates were hollering that the scheme was a diversionary stall.

But the Professor's uninhibited "Harumph" gave him the floor. "Our problem," he continued, "is to revise a registration examination question asking for the power required to raise one ton 495 ft in a certain time. If we set the time carefully, the power required for standing start and finish will be double that for running start and finish. Cal, I don't see Joe Kerr, so . . ."

"Joe flunked that exam and he's home cramming for the next one," explained Cal Klater. "Maybe I can make a mistake for him. From a standing start under constant power, the energy equation is:

$$Pt = Wh + \tfrac{1}{2}Mv^2 \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

in which P = power in ft-lb/sec, t = elapsed time in sec, W = weight in lb, h = height in ft, M = mass = W/g, and v = velocity in fps. Differentiating with respect to t:

$$P = Wv + Mvdv/dt \quad . \quad . \quad . \quad . \quad . \quad (2)$$

$$dt = Mvdv/(P - Wv) \quad . \quad . \quad . \quad . \quad . \quad (3)$$

and integration leads to

$$W(v + gt) = -P \log (1 - Wv/P) \quad . \quad (4)$$

"Acceleration continues until v_1 is the velocity at time t_1; power is then shut off and deceleration is expressed by $v = g(T - t)$ until the weight reaches height H at total time T. Power required by alternative operations can be expressed by $WH = Pt_1 = \frac{1}{2}PT$, so that $T = 2t_1$ and $v_1 = gt_1$. Substituting and letting $gT^2 = 2Hu$, where u is a dimensionless parameter, we find

$$\tfrac{1}{2}u = 1 - e^{-u} \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

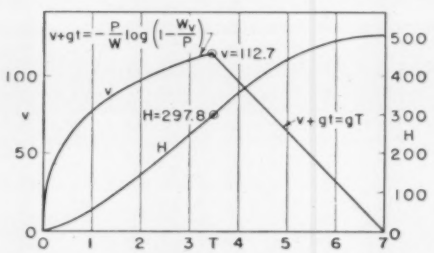


FIG. 1. Motion at Constant Power Against Gravity

This can be solved by series or cut-try. Finding $u = 1.5936$, and substituting $H = 495$ and $g = 32.197$, I computed 7sec for the time T which should have been specified."

"That's a very convenient value of g, Cal. I can add a general expression for (5) if the running-start power is specified as kP, where $k < 1$, then:

$$u(1 - k) = 1 - e^{-u} \quad . \quad . \quad . \quad . \quad . \quad (6)$$

which has a simple series solution when u is large.

"Appropriate for May is a kind of 'fifth degree.' A circular silo 20 ft in diameter is tangent to a straight caprielude fence at a post, to which a goat is tethered on the same side of the fence. Doubling the length of the rope would increase Nanny's grazing area by 400 percent. How long is the rope?"

[*The Joe-Cal ratio was exceptionally large, as few reached the simple Eq. 5. Cal Klater were Ed. C. Holt, Jr., and Victoria Mase (J. S. Kendrick).*]

Meetings and Conferences

American Water Works Association. All meetings and exhibits of the 69th annual conference of the American Water Works Association are scheduled for the Stevens Hotel in Chicago, Ill., May 30 through June 3.

Central States Sewage Works Association. Headquarters for the annual convention of the Central States Sewage Works Association will be the Hotel Sherman, Chicago, Ill., on June 17 and 18.

Fourth Hydraulics Conference. A symposium on "Engineering Hydraulics," to be published later in book form, will highlight the program for the Fourth Hydraulics Conference at Iowa City, June 12-15, sponsored by the Iowa Institute of Hydraulic Research. Inquiries should be addressed to the Iowa Institute of Hydraulic Research, State University of Iowa, Iowa City, Iowa. (See March issue, page 63.)

Instrument Society of America. Four technical sessions are planned for the spring meeting of the Instrument Society of America, to be held at the Royal York Hotel, Toronto, Canada, May 12 and 13.

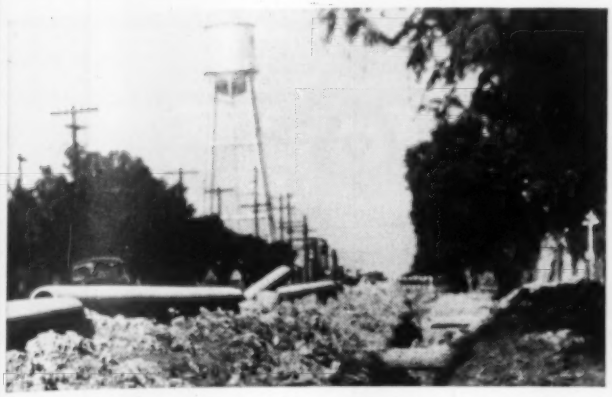
Michigan Safety Conference. A safety conference and traffic engineering school, where the subject of traffic engineering fundamentals will be treated from the practical approach, feature the program of the Michigan Safety Conference, to take place, at the Book-Cadillac Hotel, Detroit, Mich., May 19-20.

Society for Experimental Stress Analysis. Techniques of stress measurement will be discussed at the spring meeting of the Society for Experimental Stress Analysis at the Hotel Statler, Detroit, Mich., on May 19 through 21.

The Society of Naval Architects and Marine Engineers. Technical sessions, inspection trips, and social events are scheduled for the spring meeting of the Society of Naval Architects and Marine Engineers at the Palace Hotel, in San Francisco, Calif., May 12 and 13.

Third Annual Florida Highway Conference. Under the sponsorship of the Civil Engineering Section of the Engineering and Industrial Experiment Station of the University of Florida, the Third Annual Florida Highway Conference will be held at Gainesville, Fla., May 9-11.

This intrinsic resistance to corrosion has been substantiated by numerous Transite installations. Some of these have been exposed to highly aggressive soils, both alkaline and acid, for many years. Many are now serving as replacements under conditions so destructive that the useful life of the pipe materials previously used had been seriously curtailed.



Transite Pipe was installed in this Texas city ten years ago to replace another pipe material that had been destroyed by soil corrosion in 7 years. The Transite mains are still on the job today with a long useful life ahead of them.

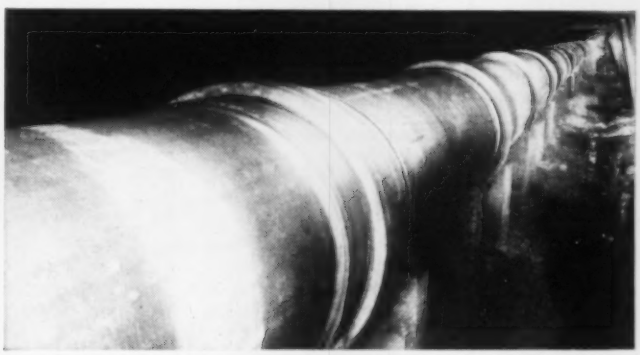
In one such installation, a Transite main installed during 1932 in an extremely corrosive soil was recently made the subject of careful study to determine its condition. Sections of the pipe, including couplings, were dug up and shipped to the factory for test. There was no evidence of deterioration. Pipe and couplings readily withstood the original factory pressure test, equivalent to four times the normal working pressure of the line.

Like thousands of other communities, this West Virginia city selected Transite Pipe because it promised assurance of maximum life. Today, after 14 years of service, the first installation of Transite has already fulfilled this promise by outlasting the pipe material previously used.

Certain types of industrial service provide an even more severe "proving ground" for the life expectancy of pipe materials, and here, too, Transite Pipe has demonstrated exceptional corrosion resistance. Coal mine service is a typical example. Here acid mine waters are frequently so corrosive that they have destroyed ordinary pipe materials in a matter of a few months or years. Yet Transite Pipe has handled these same waters under working pressure up to 150 lbs. for periods from 10 to 15 years with little, if any, indication of deterioration.

Corrosive soil conditions were so severe at this location in a prominent New England city that the life of the pipe material formerly used was only 15 years. Transite Pipe, put in as a replacement in 1934, continues to give the same efficient, dependable service as the day it was installed.

To evaluate the ability of pipe materials to withstand soil corrosion, the National Bureau of Standards has conducted an extensive series of field tests. These studies are based on examination of hundreds of pipe samples periodically removed from severely corrosive soils. In these and similar tests, Transite Pipe has consistently demonstrated its superior resistance to soil corrosion, confirming the long life expectancy which this asbestos-cement pipe has evidenced in thousands of water works installations.



Transite's ability to provide long-term, dependable service is well illustrated by its performance in coal mines, where it consistently outlasts other pipe materials in carrying corrosive mine drainage waters. The 36" Transite line shown above has been conveying acid mine waters for 15 years.

For further details about Transite Pressure Pipe, write Johns-Manville, Box 290, New York 16, N. Y.

JOHNS-MANVILLE JM PRODUCTS

Positions Announced

Community Redevelopment Agency of the City of Los Angeles. Applications for the position of executive director of the Los Angeles Community Redevelopment Agency may be filed until May 31. The position, which carries an annual salary of $11,280, involves responsibility for directing the activities and administration of the Agency, including planning, organizing, and executing the city's redevelopment program. Qualifications include graduation from college, with a major in engineering, architecture, or business or public administration, and at least eight years of organizational or planning experience, with four in a responsible administrative capacity. Application forms may be obtained from the Agency, Box 2316 Terminal Annex, Los Angeles 54, Calif.

Milwaukee City Service Commission. Superintendent of Bridges and Public Buildings. Beginning salary $7,200 per annum advancing to $8,100. Applicants must be graduate or registered engineers with 10 years of responsible structural engineering experience, preferably in bridge design and construction. Maximum age 50. Appointee will obtain permanent civil service status and become a member of a sound retirement system. Rating will be based on the training, experience, and exhibits of applicants. No other written examination. Write City Service Commission, City Hall, Milwaukee, Wis., for detailed announcement, application, and experience questionnaire.

U.S. Civil Service Commission. Positions as Cartographic Aid and Cartographer in Washington, D.C., and in mobile field units operating in various parts of the country have been announced by the Civil Service Commission. Salaries for cartographic aids range from $2,152 to $3,727 a year and, for cartographers, from $4,479 to $7,432 a year. Further information and application forms may be obtained from the Commission in Washington, Civil Service regional offices, or post offices.

NEW IN Education

PLANS FOR IMMEDIATE construction of a Hydrodynamics Laboratory and Model Ship Towing Tank at the Massachusetts Institute of Technology have been announced by Dr. James R. Killian, Jr., president of the Institute. The first project undertaken in the Institute's $20,000,000 development program, the new laboratory will provide extensive facilities for research in the behavior of liquids and gases. The cost of the project is estimated at more than $500,000.

PLANS ARE BEING completed for the Seventh Annual Illinois Conference on Surveying and Mapping, at the University of Illinois, on May 27 and 28. Sponsoring organizations are the departments of civil engineering of the University of Illinois and the Illinois Institute of Technology, and the Division of Engineering Sciences, Navy Pier Branch, University of Illinois.

A STUDENT REPLICA of a UNESCO world conference, held recently at the University of Nebraska, constituted an innovation. Student delegates, appointed to "represent" the 44 member nations of UNESCO, discussed a wide variety of subjects aimed at "the promotion of understanding through cultural exchange."

FUNDS AVAILABLE FOR the Joint Highway Research Project, conducted at Purdue University as a cooperative enterprise of the university and the State Highway Commission of Indiana, have been augmented by recent action of the legislature increasing the annual state allocation to the university from $50,000 to $150,000. In addition, the Commission has been authorized to pay to the university "for engineering and economic investigations" funds available to the state under federal aid, making it possible for the Commission to spend as much as $300,000 for highway research at Purdue. The project is operated by the Engineering Experiment Station under the immediate direction of Prof. R. B. Wiley, M. ASCE, head of the School of Civil Engineering and Engineering Mechanics, and Prof. K. B. Woods, M. ASCE, associate director.

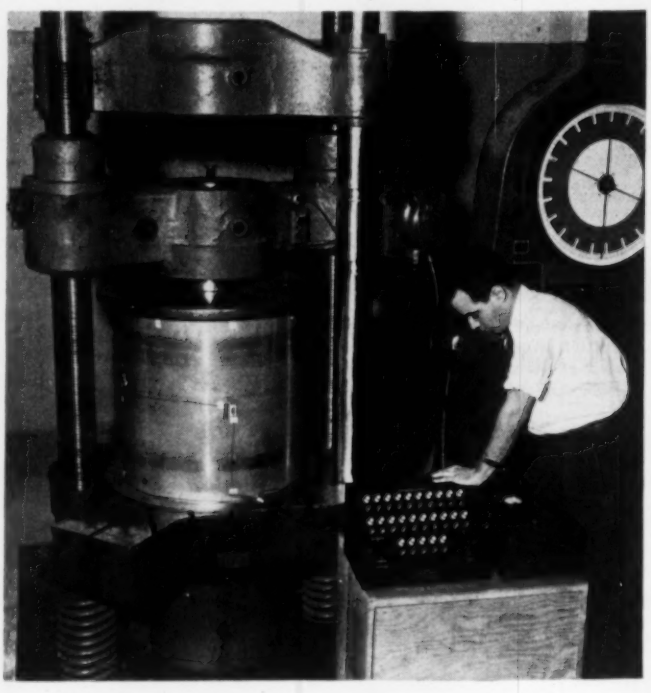
PIONEER RESEARCH ON dimensional changes that may occur inside reinforced concrete beams is being undertaken at the University of Michigan by Ala E. Fatin, an Egyptian engineer working at the university for his doctorate, who has perfected a method of burying electric strain gages inside concrete beams without affecting their accuracy in recording expansion or contraction. According to Robert H. Sherlock, M. ASCE, professor of civil engineering, who is directing the work, previous use of electric strain gages in concrete research has been limited to the recording of surface changes. "Up to now," he said, "it has been impossible to determine the amount and distribution of the changes that occur throughout the entire mass of concrete."

LEHIGH UNIVERSITY HAS announced that two DuPont Company Fellowships, one Westinghouse Fellowship, and the George Gowen Hood Fellowship, together with 35 additional scholarships and fellowships, will be available for the academic year 1949-1950. These awards range in value from $1,000 to $1,800 and, in most cases, provide free tuition. In the case of the specific offerings listed, the holder will devote full time to work for an advanced degree. Further information and application forms are available from Dean Wray H. Congdon, Director of Admissions, Lehigh University, Bethlehem, Pa.

TO ENCOURAGE COLLEGE students to enter the highway engineering field, the Kentucky Department of Highways is conducting a cooperative program with the University of Kentucky College of Engineering. Under this plan, 18 Student Engineering Employees will be selected each

(Continued on page 86)

Tests for Aeronautical Construction Made in New York University Laboratory



NEW 200,000-LB TESTING MACHINE, recently installed in aeronautical department of New York University College of Engineering, is used in research tests involving "sandwich" type of construction. In photograph, graduate student arranges wires connected to strain gages on large cylinder in testing machine, which will be stressed gradually to buckling point. Sponsored by Office of Naval Research, project has for its objective development of design formulas which will apply to type of structure consisting of two metal faces separated by low-density plastic core.

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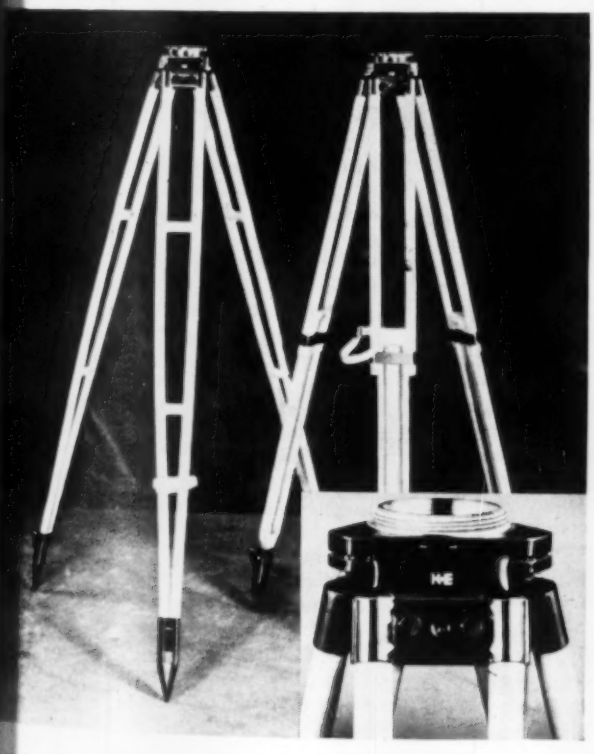
partners of the draftsman, the engineer and the scientist in shaping the modern world

NEW K&E WIDE FRAMED TRIPODS GIVE MAXIMUM STABILITY

The wide framed leg construction of these new K&E tripods and the wide, all-metal hinges joining the legs and head result in great torsional stability. This makes the instrument much steadier—less vibration—in windy weather. Legs are straight grained maple. They are easy to plant firmly, because of their long steel "Stoodite" tipped shoes and large spurs—the kind a man can get his foot on, even with boots or galoshes. The head fits all instruments with the standard 3½ inch by 8 threads. K&E Wide Framed Tripods are made in stiff leg and extension styles.

Ask your K&E Dealer or Branch to show you these tripods, or write to Keuffel & Esser Co., Hoboken, N. J.



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ALBANENE Tracing Paper is made from a 100% pure rag base. Its fine printing transparency is due, not to oils that leak and "bleed," but to a synthetic transparentizer that K&E developed specially for this purpose. Prints made today from drawings made on ALBANENE years ago, prove conclusively that ALBANENE does not turn brittle nor lose its transparency with time.

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year by competitive examination from the nine highway districts in the state for enrollment in the College of Engineering. Students will alternate three years of regular academic work with three years of employment in the field, office, or laboratory work of the Highway Department, with pay at regular rates. At the end of the six-year period, they will be qualified to receive the degree of bachelor of science in civil engineering. Further information may be obtained from any district engineer in the Highway Department or the College of Engineering at the University of Kentucky, Lexington 29, Ky.

NEWS OF Engineers

Louis R. Douglass, assistant director of the Bureau of Reclamation, Region III, Boulder City, Nev., recently returned from a two-month tour of duty in Japan as an adviser to General MacArthur's headquarters staff on irrigation developments now under way in that country. His recommendations for irrigation improvements are given in a report to the Supreme Commander for the Allied Powers.

Ralph C. Hansen, since 1945 structural engineer for the engineering department of the Libbey-Owens-Ford Glass Co., at Toledo, Ohio, has been transferred to the glass packaging and handling division at Rossford. Mr. Hansen will serve in the capacity of engineer of that division studying packaging and handling methods.

Sylvan C. Martin, previously executive assistant, Federation of Sewage Works Associations, Champaign, Ill., has been appointed senior sanitary engineer to head the Great Lakes Branch Basin office of the Division of Water Pollution Control at Chicago, Ill. This office is being created to coordinate the federal water pollution control activities with state, interstate, and local agencies as provided in the recently enacted Water Pollution Control Act.

William H. Mills, chief of the Airport Division of the Civil Aeronautics Administration at Atlanta, Ga., has been appointed district engineer in charge of the newly established office of the Asphalt Institute. He will be located at Atlanta, Ga.

Howard S. Morse, vice-president and manager of the Indianapolis Water Co. since 1925, has been promoted to executive vice-president of that utility. He will be succeeded as vice-president and manager by **Alfred O. Norris,** former vice-president and general manager of Birmingham (Ala.) Water Works Co. Mr. Morse served the Society as Director from 1935–1937.

Charles Wright, until recently construction engineer with the Tennessee Valley Authority, has become associated with the Midland Construction Co., of Chicago, Ill.

Clarkson H. Oglesby, acting assistant professor, department of civil engineering at Stanford University, was promoted to the rank of associate professor at the beginning of the academic year in September.

Royden E. Reed has been forced by illness to resign from the position of division budget administrator and division assistant treasurer of Consolidated Vultee Aircraft Corp., Fort Worth, Tex. Mr. Reed plans to return to his home in Manchester, N.H.

C. O. Schofield is now engineer-in-charge of the Wichita-Valley Center Flood Control Project, Wichita, Kans. He will represent the City of Wichita and Sedgwick County (Kansas) on work to be done by the Tulsa, Okla., District of the Corps of Engineers.

Thomas Smithson, formerly consulting and designing engineer with U. Ernest Nelson, Portland, Ore., consultant, announces the establishment of a consulting office for the practice of civil and sanitary engineering under his own name at Cedar Hills, Beaverton, Ore.

Harvey R. Wilke recently joined the staff of the Purdue University School of Civil Engineering and Engineering Mechanics as associate professor of sanitary engineering. In addition to his teaching assignments, he will direct research projects in the field of water treatment and participate in extension work in the State of Indiana. For the past three years, Mr. Wilke has been an engineer in the Missouri State Division of Health.

George M. Slaughter has been appointed instructor of hydraulic engineering at the Louisiana State University, where he will teach courses in fluid mechanics and hydrology. Mr. Slaughter has been with the U.S. Geological Survey in Ohio and with the Hydraulic Laboratory of the Tennessee Valley Authority at Norris, Tenn.

Edward W. Benes is now with the Division of Architecture, Division of Highways, Sacramento, Calif. Mr. Benes previously maintained a private practice at Brigham City, Utah.

Alvin M. Fromherz, New Orleans, La., consultant, announces that **Frank C. Fromherz** and **Thomas A. Fromherz** are now associated with him for the practice of civil, sanitary, and structural engineering, under the firm name of Fromherz Engineers.

Sol Pincus, New York City consultant, has gone to Geneva, Switzerland, where he will set up a Section on Environmental Sanitation for the World Health Organization. During the first World Health Assembly held last summer, environmental sanitation was made one of the six top priority programs of the World Health Organization for 1949. Appointed deputy commissioner, New York City Department of Health, in 1935, Mr. Pincus directed sanitary engineering and food control activities until 1947, when he returned to his private practice that has been interrupted by municipal service.

J. O. Colvard, Jr., civil engineer, announces the establishment of a concern to practice engineering and architecture at Decatur, Ala., with John W. Thomas, architect, and I. V. Timberlake, Jr., as associates.

T. W. Rodgers, who completed an assignment for the Bridge Department in Fresno, Calif., for the California State Division of Highways, on the Monterey Street Overhead, is now located at Sacramento with the Bridge Maintenance Section.

H. H. Tarzian, formerly structural engineering associate with the Bridge Department of the California Division of Highways, has left for the Philippines, where he will be employed for about three years by the Public Roads Administration on bridge projects.

Roy L. Klema, formerly a partner in the civil engineering firm of Walsh and Klema, of Los Angeles, Calif., has opened a consulting office at Kanakee, Ill.

William H. Nalder has been appointed chief designing engineer, U.S. Bureau of Reclamation, Denver, Colo. Mr. Nalder has been with the Bureau for about 4½ years—recently as assistant chief designing engineer. He is the first to hold the title of chief designing engineer since the retirement of **John L. Savage,** Hon. M. ASCE, in 1945.

T. H. Evans has resigned as director of the School of Civil Engineering at Georgia Institute of Technology, to accept the position of dean of engineering at Colorado A. & M. College. Colonel Evans served four years in the Army during the second World War, and prior to the war was associate professor of civil engineering at the University of Virginia. At present he is president of the Georgia Local Section, and a member of the ECPD accrediting committee on engineering schools for the Southeastern Region.

T. H. Evans

Leo H. Corning, since 1935 assistant manager of the Portland Cement Association's Structural and Railways Bureau, Chicago, Ill., has been appointed manager of the Bureau, succeeding the late **Arthur J. Boase,** who was manager for 16 years.

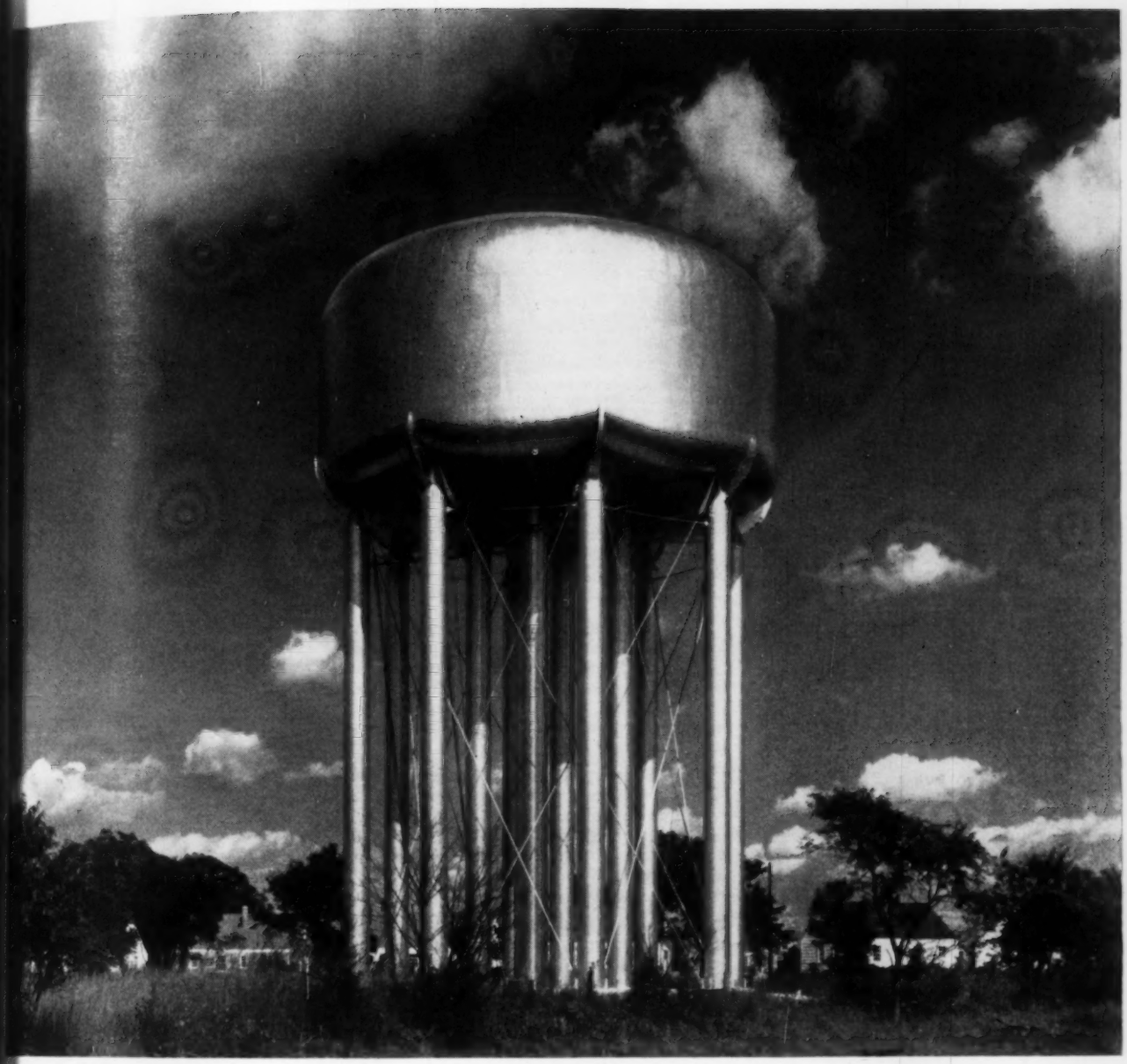
R. A. Rait, with the Humble Oil and Refining Co., of Houston, Tex., has been promoted to division civil engineer of the newly created Gas Construction Division at Houston.

R. H. Stalnaker has retired from the post of principal equipment engineer of the California Division of Highways, Sacramento, where he has been in charge of the Equipment Department from the time of its organization in 1921. He will be succeeded by **Earl E. Sorenson,** former equipment engineer of the Division of Highways at Sacramento.

Howard H. Sturdy, general manager of the Contracting Division of the Dravo Corp., Pittsburgh, Pa., has been named one of the new Dravo directors. Starting as a field engineer with the organization in 1909, Mr. Sturdy was appointed to his present position in 1947.

Ivan C. Ethington is now a senior instrumentman with the Chicago, Burlington and Quincy Railroad at Chillicothe, Mo.

(Continued on page 88)



How to EXPAND a Water System

Richmond, Virginia, recently annexed a large area west of the city, and became responsible for the water supply in a new "Fourth Service Area." In order to prevent inadequate service in other parts of the city, and as a precaution against pump failure, two 1,000,000-gal. Horton elevated tanks were installed in the new area to supplement existing pumping equipment with gravity water pressure.

A "pressure-flow" control system has been installed in which the pumps are started when the pressure drops to a predetermined figure. They operate until they have delivered to the tanks a predetermined quantity of water, regardless of pressure. The tanks then serve the system until low pressure again starts the pumps. Some of the advantages of this control method are (a) maximum pumping efficiency with lower power costs, (b) freedom to locate the tanks where they will work most effectively, and (c) elimination of the need for installing new transmission mains.

Two 1,000,000-gal. Horton tanks have been erected at Richmond. Both are of the radial-cone type—a design which is used in large capacity tanks (500,000 to 2,500,000 gals.) to prevent excessive ranges in head.

Ask our nearest office for details and estimating figures.

Above: One of the two 1,000,000-gal. Horton radial-cone bottom tanks installed at Richmond. This one is 77 ft. 6 in. to bottom and has a 35-ft. range in head.

CHICAGO BRIDGE & IRON COMPANY

Atlanta 3	2167 Healey Bldg.	Detroit 26	1541 Lafayette Bldg.
Birmingham 1	1596 N. Fiftieth St.	Havana	402 Abreu Bldg.
Boston 10	1009-201 Devonshire St.	Houston 2	2128 National Standard Bldg.
Chicago 4	2199 McCormick Bldg.	Los Angeles 14	1556 General Petroleum Bldg.
Cleveland 15	2263 Guildhall Bldg.	New York 6	3395-165 Broadway Bldg.
Philadelphia 3	1652-1700 Walnut St. Bldg.		
Salt Lake City 1	1509-1st Security Bank Bldg.		
San Francisco 11	1284-22 Battery St. Bldg.		
Seattle	1309 Henry Bldg.		
Tulsa 3	1647 Hunt Bldg.		

Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY and GREENVILLE, PENNA.

(*Continued from page 86*)

Oliver J. Todd has returned to China to serve the Joint Rural Reconstruction Commission as an engineer and member of the Economic Cooperation Administration for China. Mr. Todd formerly spent about 20 years in engineering work in China, where he assisted with surveys of the Grand Canal. In 1946–1947 he was adviser on the UNRRA Yellow River Conservancy. Mr. Todd has contributed articles to CIVIL ENGINEERING on flood control and other projects in China.

Oliver J. Todd

Markham E. Salsbury, Los Angeles, Calif., engineer, is temporary chairman of the newly created California Legislative Council of Professional Engineers, and **J. G. White,** Structural Engineers Association of Northern California delegate, is temporary treasurer. Formed as a central organization, the Council will represent all branches of the engineering profession in California on legislative matters.

Jack Y. Long, Oakland, Calif., consultant, is president of the East Bay Structural Engineers Society of San Francisco.

Henry M. Paynter, of Dover, Mass., instructor of civil engineering at Massachusetts Institute of Technology, has been awarded second prize in the Junior Essay Contest conducted by the Engineering Societies of New England for his treatment of this year's topic, "The Obligations of the Engineer to a Free Society." A graduate of M.I.T., he is now a doctoral candidate in hydraulic engineering.

Robert W. Millard, city engineer of Ely, Nev., is 1949 president of the Eastern Nevada Chapter of the Society of Professional Engineers.

Henry M. Mason, general superintendent, of the Ross B. Hammond Co., Portland, Ore., now holds the office of treasurer for the Oregon Building Congress.

Elmer K. Timby, professor of civil engineering at Princeton University, was recently named a member of the newly formed Building Research Advisory Board of the National Research Council, established to correlate and encourage research in the building field and to make results of these studies available. Professor Timby is a member of the executive committee of the ASCE Construction Division.

John S. Moore, engineer with the Bureau of Reclamation at Boise, Idaho, has been appointed superintendent of the Minidoka Project in Southeastern Idaho. In 1931, Mr. Moore superintended the Yakima Federal Reclamation Project in eastern Washington, and had charge of operation and maintenance for the entire Bureau when the unit was moved from Denver to Washington, D.C., during the years of the second World War.

ASCE members elected to offices of the Bay Counties Civil Engineers and Land Surveyors Association include: **James E. Waite,** San Francisco engineer, as president; and **Ralph E. Cotter, Jr.,** consultant of Oakland, Calif., as a director.

Melvin L. Enger, professor of hydraulics and dean of the University of Illinois' College of Engineering, will retire in September. He will be succeeded by **William L. Everitt.**

Walter T. Brooks recently resigned as chief engineer of the Department of Highways and Public Works of Tennessee to establish a branch office in Knoxville, Tenn., for the Chicago engineering and architectural firm of H. W. Lochner & Co.

Harry E. Squire, until lately assistant engineer with the California Board of State Harbor Commissioners, San Francisco, has been made chief engineer.

Abel Wolman, professor of sanitary engineering at Johns Hopkins University, has accepted the appointment of lecturer and research consultant in sanitary engineering.

D. B. Gumensky, chief designing engineer of the National Hydroelectric Engineering Bureau in China, has returned to the United States and opened a consulting office in Los Angeles, Calif. He will specialize in the fields of hydraulic and structural engineering.

Carl Shriver, recently retired from the Corps of Engineers after serving for 28 years, is now associated with the Alabama State Planning Board, Montgomery, Ala. Colonel Shriver will help the Board in its investigation of water resources.

W. E. Jones, formerly design engineer of the Iowa State Highway Commission, Ames, Iowa, has become assistant to the chief engineer of the Commission.

Herman V. Yank announces that he is opening an engineering office at Fresno, Calif., where he will specialize in the structural and civil engineering field. He was previously employed by the San Francisco consulting firm of A. W. Earl.

Kenneth B. Anderson has been named chief deputy engineer of Franklin County, Ohio, with headquarters at Columbus. For approximately eight years, Mr. Anderson has been city engineer of Pontiac, Mich.

James G. Dickson, formerly field engineer, Texas State Highway Department, San Antonio, has opened a consulting engineering office at Freeport, Tex.

Raymond A. Hill, former Director, has been commended by the Los Angeles Section for his "unselfish and untiring volunteer efforts" while supervising rescue operations to recover 3-year-old Kathy Fiscus, of San Marino, Calif., who fell 100 ft into an abandoned well and was found dead.

William L. Zeigler, of the Dallas firm of Zeigler, Houseman & Associates, was elected vice-president of the Dallas Chapter of the Texas Society of Professional Engineers for this year. Named to the Board of Directors are ASCE members: **R. Trent Campbell,** of the Mosher Steel Co., and **O. H. Koch,** of Koch & Fowler.

Deceased

Ralph Whitley Berry (M. '28) topograph engineer and map editor for the U.S. G logical Survey, Washington, D.C., died cently at the age of 69. His home was Kensington, Md. Mr. Berry had been the Geological Survey since his graduat from Vanderbilt University in 1901, en for a year with the Isthmian Canal Com sion in Panama, a period of service in Army Corps of Engineers during World and four years in private engineering surveying practice. An expert cartograph he received an Award of Merit from the partment of the Interior for maps of Pacific islands made for the Army in Wo War II.

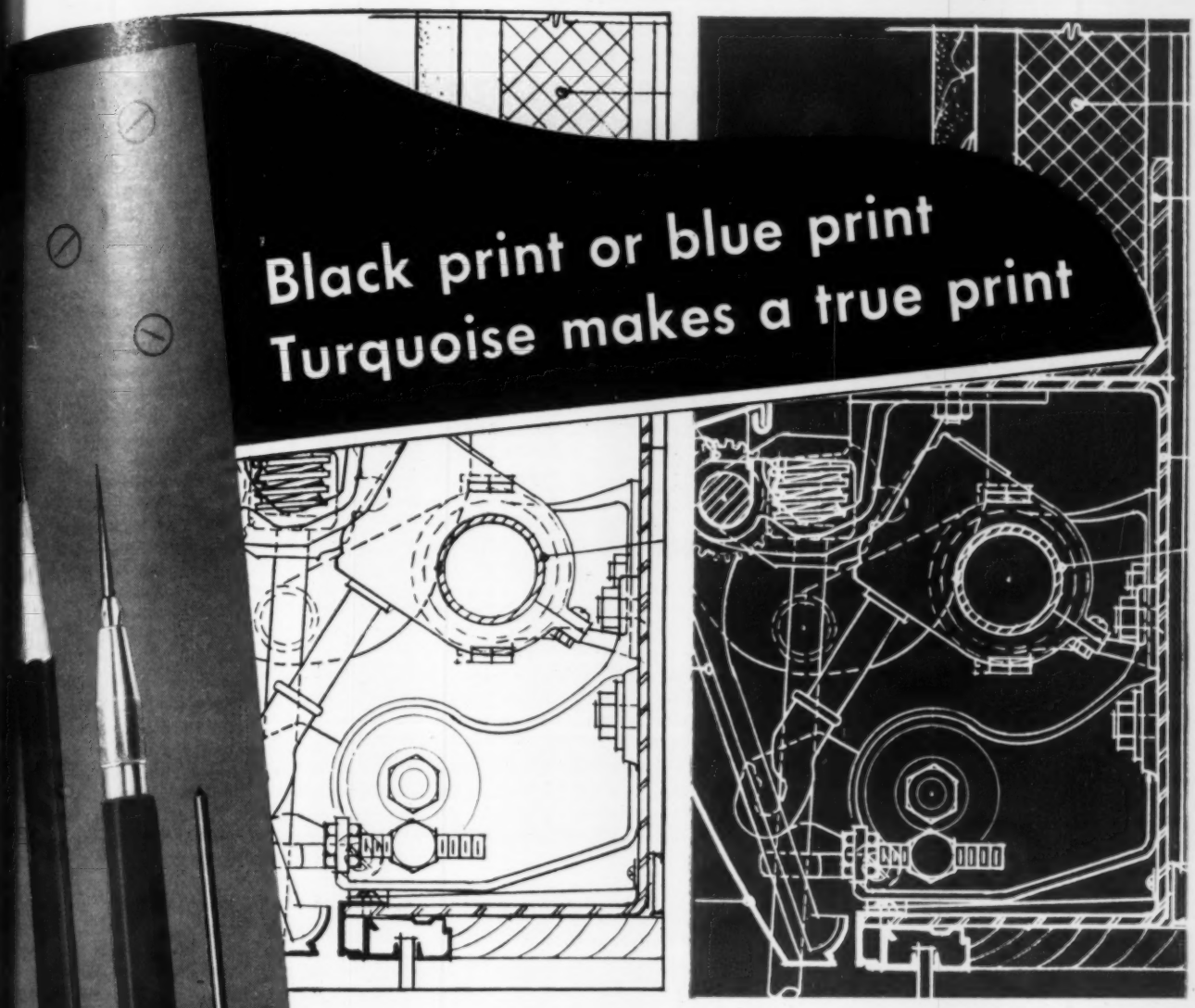
Herbert Henry Brown (M. '32) supe intendent of water works for the City Milwaukee, Wis., died on January 7, at age of 54. Upon his graduation from University of Wisconsin in 1917, Mr. Brow entered the Army Infantry, serving as captain for the duration of World War I. the engineering employ of the City of M waukee since 1922, he had held positions engineer in charge of the design and co struction of the city pumping stations a water purification plant, and had been supe intendent of water works since 1941. M Brown was prominent in the Americ Water Works Association, and had pu lished numerous articles on water engine ing subjects.

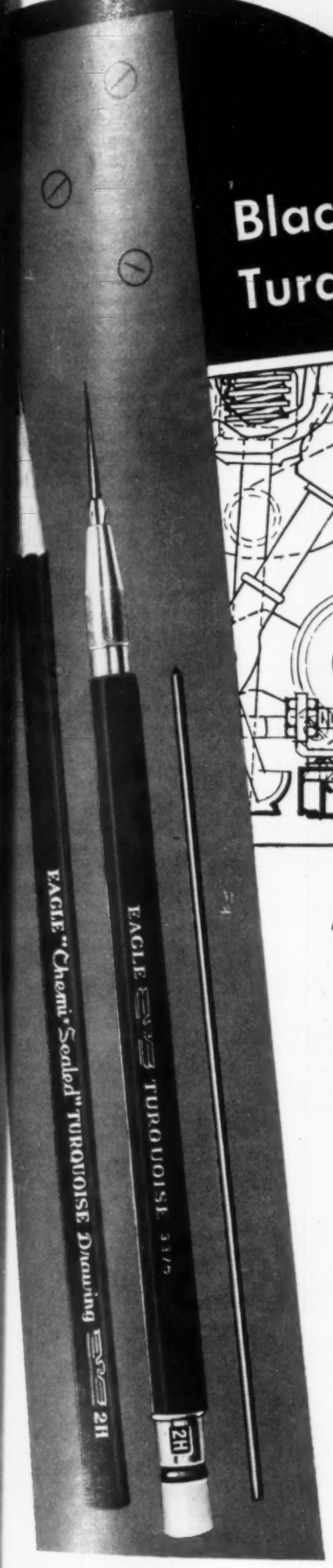
Joseph Jay Durfee (Assoc. M. '15) Stewart Manor, N.Y., died on March 3, the age of 64. Mr. Durfee had been field e gineer and assistant superintendent on co struction of the William Street subway New York City, and was engaged on the co struction of a water supply system for Cur Bay, Md., and a filtration plant for t Akron (Ohio) Water Works. More recent he was chief field engineer for Drydock A sociates, Philadelphia. He was a civil e gineering graduate of Lafayette College.

Claes Theodore Ekman (Assoc. M. '1 director of the Division of Water Resourc and Engineering of the Minnesota State D partment of Conservation, St. Paul, di on December 4, 1948, according to word j received at Society Headquarters. He w 61. A graduate of the University of Minn sota College of Engineering, Mr. Ekman h extensive experience in engineering a architectural design and construction, both public and private practice. He join the Division staff as chief designing engi in 1936, and had been director for 14 mon at the time of his death. The Ninth Bien Report of the Division (reviewed in t "New Publications" department of th issue) was prepared largely under his dir tion.

John Francis Greathead (Assoc. M. '1 civil engineer of Vallejo, Calif., died

(*Continued on page 90*)





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(*Continued from page 88*)

March 3, at the age of 62. A graduate of the University of Pennsylvania, Mr. Greathead had been in charge of subway construction for the New York Public Service Commission and the Philadelphia City Transit Department. Beginning in 1922, he was for many years with the Bureau of Yards and Docks, successively as field engineer and civil engineer at the Mare Island Navy Yard.

R. Prosper Gustin (Assoc. M. '07) of Mount Vernon, N. Y., died on December 4, 1948, according to word recently received at Society Headquarters. He was 77, and a graduate of the University of Michigan, class of 1895. Beginning in 1907, Mr. Gustin was for a number of years with the Degnon Contracting Co., of New York City, in charge of various subway construction projects and of work on the Hudson River tubes. His engineering work was done largely in the metropolitan area.

John Jacob Heilman (M. '22) chief engineer, A. B. Rote & Co., Lancaster, Pa., died on March 1. Mr. Heilman, who was 70, had been with A. B. Rote & Co. as chief engineer in charge of design and detail of structural steel work since 1925. His earlier positions were with the Lancaster Structural and Foundry Work, the Bethlehem Steel Co., and the Cambria Steel Co. He had degrees from Muhlenberg College and the University of Pennsylvania.

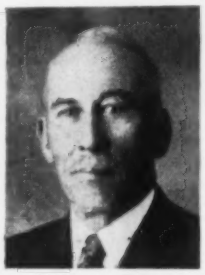
Moses Josiah Guyton (M. '25) postmaster of Dublin, Ga., died in a hospital there on January 30, at the age of 68. Before becoming postmaster in 1934, Mr. Guyton was for many years city engineer of Dublin. In the latter capacity, he was responsible for many of the city's public construction and improvement projects, and for maintenance of its public utilities. He was an alumnus of Emory College, class of 1902.

Samuel Henry McCrory (M. '15) an authority on drainage and flood control, died recently at his home in Washington, D.C. He was 69. An official in the Department of Agriculture from 1906 until his retirement in 1946, Mr. McCrory organized the department's Bureau of Agricultural Engineering. During World War I, he was given the special assignment of passing on drainage projects for which bonds had been issued, and in the recent war was in charge of hemp production in the United States. In 1938 Mr. McCrory was awarded the John Deere Gold Medal of the American Society of Agricultural Engineers for outstanding achievement. After his retirement in 1946, Mr. McCrory went to Iraq and Iran on a United Nations flood-control project, and also made a flood-control study for the Egyptian government.

Samuel H. McCrory

J. Quincy Barlow, Long on ASCE Rolls, Is Dead

J. QUINCY BARLOW, retired San Francisco consultant and second oldest ASCE member in point of Society affiliation, died in Berkeley, Calif., on March 19. Mr. Barlow, who was 87, joined the Society as a Junior in 1886 and had been a full member since 1888.



J. Quincy Barlow

An alumnus of Worcester Polytechnic Institute, class of 1882, he recently received the honorary degree of doctor of engineering from the institute. From his graduation until 1923 Mr. Barlow was engaged in railroad engineering. During this long period he held such positions as chief engineer of the Western Maryland Railroad; chief of maintenance of the Southern Pacific Railroad System; and regional engineer for the U.S. Railroad Administration, Pacific and Southwestern regions.

Beginning in 1923, Mr. Barlow was for many years engineering consultant and chief engineer of the Utah Construction Co., builders of large dams, tunnels, railroads, and canals.

Harry Lewis Haehl (M. '18) consulting engineer of San Francisco, died on January 29, at the age of 72. A graduate of Stanford University, Mr. Haehl gained early experience as assistant engineer for the Bay Cities Water Co. and as first assistant engineer in charge of field and office investigations for construction of the Sierra water supply for San Francisco. As a member of the firm of Duryea, Haehl & Gilman from 1907 to 1920, Mr. Haehl was engaged on the design and construction of numerous West Coast water supply and irrigation projects. Later he maintained his own practice, specializing in irrigation, reclamation, and water supply problems.

W. Scott Johnson (M. '33) director of the Section of Environmental Sanitation, Division of Health of Missouri, died suddenly at his home in Jefferson City, Mo., on March 13. He was 52. Mr. Johnson held degrees from the University of Kansas and Harvard University. He had been on the Missouri State Board of Health since 1923, and was recently honored for his achievements during 25 years of public health engineering in Missouri. He was a past-president of the Engineering Section of the American Public Health Association and a former chairman of the Conference of State Sanitary Engineers, and the author of articles in the publications of the American Water Works Association and the American Public Health Association.

Balie Peyton Legare (M. '07) retired engineer of North Hollywood, Calif., died at his home there on March 3, at the age of 64. A graduate of Hobart College in 1888, Mr. Legare spent his early career in street railway construction in New York and Philadelphia, and as chief engineer on construction of the London underground railway. Mr. Legare went to San Francisco shortly after the April 1906 fire, as chief engineer in charge of rehabilitation and construction of the Market Street Railway Co. He retired in November 1941 after 35 years with the company. Mr. Legare was a member of the Concrete Institute of London, and member and past-president of the Engineers' Club of San Francisco.

Adriel Raymond McCreary (M. '40) vice-president of Paugh & Brown, Inc., Cleveland, Ohio, died on December 26, 1948, according to word recently received at Society Headquarters. He was 63, and an alumnus of the Case School of Applied Science. Mr. McCreary had been superintendent of construction for the Foundation Co., New York City; architect's superintendent for Albert Kahn, Detroit engineer and architect, and general manager for Harry A. Fulton, Cleveland architect. For several years he also headed his own general contracting company, with headquarters in Cleveland and Lakeland, Fla. He had been vice-president of Paugh & Brown since 1941.

Raymond Stuart Melvin (Assoc. M. '31) associate engineer, California Railroad Commission, San Francisco, died on February 10. Mr. Melvin, who was 61, had been with the California Railroad Commission since 1920. Prior to that he was employed on various California irrigation projects and, earlier in his career, had been with the Western Pacific Railway and the Southern Pacific.

Franklin Dean Stewart (M. '30) assistant chief engineer of the Ohio State Department of Health, Columbus, Ohio, died there on March 10. He was 60. A former lieutenant colonel in the Army Corps of Engineers, Mr. Stewart had been with the Ohio Health Department since 1918. Earlier he was an engineering assistant to A. E. Kimberly, Columbus consultant. He was a civil engineering graduate of Ohio University.

Benjamin Russell Wood (M. '19) civilian chief of the engineering division of the North Pacific Division of the Corps of Engineers, was fatally stricken on March 13, aboard a train en route to his home in Portland, Ore., from Washington, D. C., where he had been attending a meeting. Except for a brief period as head of his own construction firm in San Francisco, Mr. Wood had been in the Corps of Engineers since 1908. Prior to his assignment to the North Pacific Division, he was chief engineer in the Office of the Chief of Engineers, Washington, D.C. As a major in the Corps of Engineers in World War I, he supervised construction of the Pershing Memorial Stadium in Paris, and in the recent war was decorated for his services in directing an over-all program of lock and dam construction that facilitated shipment of war materials, and for reporting on the rehabilitation of port and harbor facilities in the Philippines.

B. R. Wood

New Publications

Foreign Research. Reprints of German scientific and technical periodicals covering the war years are listed by J. W. Edwards, of Ann Arbor, Mich., in *1949 Periodical Catalog*. Inquiries concerning the catalog, which gives prices and descriptions, should be addressed to the Ann Arbor firm.

Concrete Research. Investigations on reinforced concrete wall and column footings—sponsored by the Committee on Reinforced Concrete Research of the American Iron and Steel Institute and conducted at the University of Illinois under the direction of Prof. Frank E. Richart, M. ASCE—have been reprinted from the *Journal of the American Concrete Institute* for October and November 1948. Issued in connection with the Committee's continuing research program on problems involved in the use of steel reinforcing bars in concrete construction, the report may be obtained without charge from C. A. Willson, M. ASCE, research engineer, American Iron and Steel Institute, 350 Fifth Avenue, New York 1, N.Y.

Traffic Studies. A study of the weaving and merging maneuvers of motorists has been issued as part of the Yale Bureau of Highway Traffic's long-range program to establish new criteria for the redesign of American highways. Inquiries concerning the report, entitled *Studies of Weaving and Merging Traffic*, should be addressed to the Yale Bureau of Highway Traffic, Yale University, New Haven, Conn.

Water Resources. Conservation of Minnesota's surface and underground water supplies and engineering aspects of the state's water problems are treated in Section VI of the Ninth Biennial Report of the Minnesota Department of Conservation. The report was prepared under the direction of the late Walter S. Olson, M. ASCE, and the late C. T. Ekman, Assoc. M. ASCE. Other reports in the series cover the state divisions of forestry, game and fish, lands and minerals, and state parks. Inquiries should be addressed to the Division of Water Resources and Engineering, State Department of Conservation, St. Paul, Minn.

Soil Mechanics. Two pamphlets on soil mechanics subjects are being distributed free of charge by the Amerlux Steel Products Corp., 551 Fifth Avenue, New York 17, N.Y. These are *Sheet Piling, Produced by Arbed-Belval in the Grand Duchy of Luxembourg*, and *"Belval P" Flat Sheet Piles for Cellular Structures*, by Louis Baes, presented at the Second International Conference on Soil Mechanics and Foundation Engineering in Rotterdam in June 1948.

Housing. Housing improvements since 1940, effected despite the severe strains placed on the construction industry, are detailed in a recent bulletin issued by the Construction Industry Information Committee of the Producers' Council, 815 Fifteenth Street, N.W., Washington 5, D.C. Inquiries should refer to Bulletin No. 9, *Our Housing Improvement Since 1940*.

(Continued on page 92)

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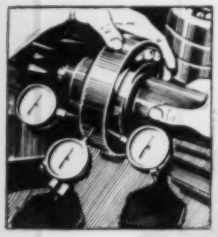

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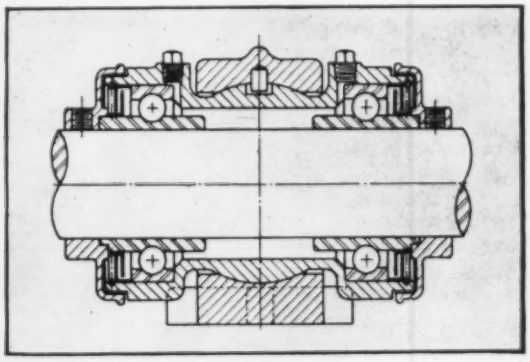

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Panel Heating. Growing interest in the subject of panel heating is reflected in the publication of an extensive bibliography on the subject by the American Society of Heating and Ventilating Engineers. This bibliography, containing over 330 references and, in many cases, brief abstracts or critical reviews, is available to non-members of the Society at 50 cents. Inquiries should be addressed to the ASHVE, 51 Madison Avenue, New York 10, N.Y.

Atomic Energy. Important developments in atomic-energy production, research, and management, during the past two years, are described in the Atomic Energy Commission's Fifth Semiannual Report to Congress, entitled *Atomic Energy Development, 1947–1948*. Copies are for sale by the Superintendent of Documents, Government Printing Office, Washington 25, D.C., at 45 cents each.

Research. A wide range of engineering and scientific research is covered in the Proceedings of the 1948 annual meeting of the Engineering College Research Council of the American Society for Engineering Education, held in Austin, Tex., in June. In addition to 13 papers by prominent engineering and scientific educators, the Proceedings contains a report of ECRC activities for the year ending July 1, 1948. Copies are available at $1 each from the ECRC, Office of the Chairman, State University of Iowa, Iowa City, Iowa.

Building Codes. Provision for the use of all new materials and types of construction that meet minimum safety standards are set forth in a 304-page *Uniform Building Code*. This edition of the uniform code incorporates the result of three years' study of the 1946 edition by municipal officials in 500 cities of the United States, Canada, Alaska, and Hawaii. The publication, which sells in paper binding for $3.25 and in cloth for $3.75, may be obtained from the Uniform Building Code, 124 West Fourth Street, Los Angeles 13, Calif. Also available from the same source is a modified edition of the parent document, entitled *The Uniform Building Code Short Form*. The latter publication, bound in paper only, sells for $1.50.

Parks. Recommendations for the development and improvement of parks in the New York metropolitan area are outlined in *Metropolitan Park Needs*, a recent brochure of the New York State Council of Parks, issued in cooperation with the New York City Department of Parks and the Westchester County Park Commission. Inquiries should be addressed to the State Council of Parks, 270 Broadway, New York 7, N.Y.

Water Resources. In its Seventh Annual Report for the year 1948, the Ohio Water Resources Board details its long-term inventory of the supply and quality of Ohio surface and underground waters, which is being conducted in cooperation with the U.S. Geological Survey. Inquiries should be addressed to the Ohio Resources Board, Columbus, Ohio. C. Vernon Youngquist, Assoc. M. ASCE, is chief engineer of the Board.

(*Continued on page 98*)

"Stay out of here folks....
this hot stove will fry you!"

WHEN the first gas range, with its promise of a cool kitchen, was exhibited at the Philadelphia Centennial Exposition in 1876, little did its sponsor dream of a market of 21,000,000 homes. For that is the extraordinary number of residential customers now served by gas for cooking, refrigeration, or home heating.

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In these three progressive branches of public service—gas, water supply and sanitation—are customers who have been buying pipe from us for 50 years. They know that we, also, have made signal progress, from decade to decade, in developing and perfecting better methods for the production of better pipe.

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Push-Button Air Traffic Control in 15 Years Predicted

(*Continued from page 51*)

matically functioning, electronic devices, and electronic 'brains' will automatically analyze and handle the majority of problems concerning the spacing and routing of aircraft."

This completely automatic system will provide continuous all-weather operation for all aircraft in the United States, Mr. Kriske believes. It will assist our national defense by enabling air operations at any time regardless of weather conditions. For the operation of commercial airlines without interruptions due to weather, the great economic advantages of the coming automatic traffic control system are obvious.

Isaac L. Ledbetter, Jr.

"Inadequately protected air terminals are a standing invitation to disaster," Mr. Ledbetter stated in his paper. Tall buildings, radio towers, trees and poles in areas adjacent to airfields are a menace not only to aircraft, but to the property itself. Believing that these hazards can be greatly reduced by proper planning implemented with zoning ordinances and enforcement, he has gathered the "working data of most major zoning requirements or recommendations that can influence an airport."

The standards reviewed include Civil Air Regulations, Part 60; Civil Air Regulations, Part 46; Model State Airport Zoning Act; Model Airport Zoning Ordinances; a Proposed Technical Standard Order; Regulations of the Administrator, Part 625; and the Army-Navy-Civil Uniform Requirements for Lighting Obstructions. Mr. Ledbetter said that progress has removed the airport from the category of a limited open area, cheaply paved runways and miscellaneous buildings and hangars. Airports have developed into efficient industrial plants where operations are precise, timed, and of a mass-production nature.

"Practically all structural engineering works affect the aviation industry in two ways. The first is high structures which fall within the category of hazard-creating obstructions. This type of structure is the one that the engineer will have immediate responsibility for in notifying the aviation public," Mr. Ledbetter stated. "The second type, which may be classified as 'non-hazardous,' affects only the aviation public, by changing the outlines of congested areas, the creation of prominent landmarks where none existed before, and the changing or obliteration of existing prominent landmarks."

"The protection of aerial approaches is one problem which can be effectively planned on an engineering basis, but which cannot be carried out except with legal implementation which has received careful planning and been coordinated with the engineering of the airport."

Gerald Pickett and Gordon K. Ray

The authors, Gerald Rickett and Gordon K. Ray, Assoc. M. ASCE, developed "influence charts for the purpose of obtaining theoretical deflections and moments of pavement slabs under load. Points at the slab edge, points near the slab edge, and points far from any slab edge are considered. Both the assumption of a subgrade modulus as originally proposed by Westergaard, and the assumption of a deep elastic solid considered by Westergaard and others are treated. The charts are based upon the theoretical equations of Westergaard and of Hogg."

The authors presented solutions to the basic equations of Westergaard and Hogg in the form of in-

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fluence charts. In obtaining the theoretical deflections and moments caused by loads on pavement slabs, they stated that it is only necessary to follow three steps: "(1) Draw the imprint of the tire or tires on transparent paper to a scale that depends on the properties of the slab and its supporting subgrade. (2) Place the drawing on the appropriate chart in a position that depends on the location of the load with respect to the point for which values are desired. (3) Count the blocks of the chart covered by the diagram."

Eight influence charts were presented which include both moments and deflections for four different assumptions and points of load as follows:

1. Interior of slab—liquid subgrade
2. Interior of slab—solid subgrade
3. Edge of slab—liquid subgrade
4. One half the radius of relative stiffness from an edge of the slab—liquid subgrade.

In this paper no effort was made to rigorously compare the different assumptions of subgrade conditions—a semi-infinite solid (the assumption of Hogg) and a semidense liquid (the assumption of Westergaard when the corrective term is not used). The authors' primary purpose is to extend the work of Westergaard and of Hogg.

Structural Engineers Feature Better Design Methods

(*Continued from page 42*)

load coincides practically with the yield point of the steel regardless of the end restraints." This paper will appear in an early issue of PROCEEDINGS.

Keith T. Fowler

Through the use of the neutral-point concept or column analogy, Mr. Fowler has developed what he terms "a rapid method of determining the slope-deflection equations for curved or haunched members. The equations obtained are valid for any deflection or rotation confined to one plane," and the only load restriction is that the load must lie in the plane of the frame. The analysis is intended primarily for three types of structures—continuous arches, aircraft bulkheads and industrial building frames.

"The extent of the application," said the speaker, "is dependent on the ability of the engineer to solve multiple simultaneous equations. Considerable accuracy is required if large numbers of equations are involved." Mr. Fowler's paper is scheduled for publication in PROCEEDINGS.

VIBER SAVES TIME AND COST IN CONCRETE CONSTRUCTION

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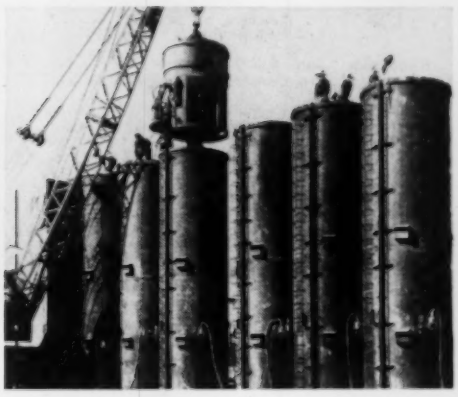

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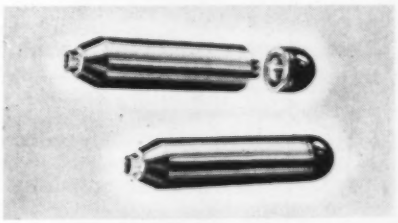

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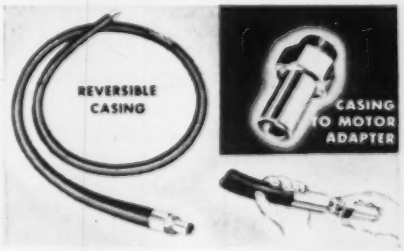

For further information or descriptive literature on Viber equipment, please write Dept. 18.

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ENGINEER; Jun. ASCE; ASME; 34; registered professional engineer. Production and plant engineering; design chemical process equipment, tablet presses, welded steel plate construction, ceramic equipment; desires position as assistant chief engineer, chief draftsman, or salesman in Philadelphia area. C-480.

STRUCTURAL ENGINEER; M. ASCE; college graduate, registered professional engineer; 25 years' experience in design and estimate of buildings, subways, water and sewage treatment works, and heavy foundations. Desires position in New York City or northern New Jersey. Available also on retainer fee basis. C-481.

CIVIL ENGINEER; Jun. ASCE; 24; married; completing work on M.S. in C.E. at Georgia Tech. in June. Interested in work on construction or design. Approximately 1 year of experience. Willing to locate anywhere that marital status can be maintained, but prefers South or Southwest U.S. or South America. C-482.

This placement service is available to members of the Four Founder Societies. If placed as a result of these listings, the applicant agrees to pay a fee at rates listed by the service. These rates—established to maintain an efficient nonprofit personnel service—are available upon request. The same rule for payment of fees applies to registrants who advertise in these columns. All replies should be addressed to the key numbers indicated and mailed to the New York Office. Please enclose six cents in postage to cover cost of mailing and return of application. A weekly bulletin of engineering positions open is available to members of the cooperating societies at a subscription rate of $3.50 per quarter or $12 per annum, payable in advance.

CIVIL ENGINEER; Jun. ASCE; bachelor's degree in civil engineering; master's in administrative (industrial) engineering; 3 years' experience; 1 year with consulting engineer designing and detailing reinforced concrete, general takeoff; 2 years with steel fabricator, sales work; estimating; detailing and designing structural steel, primarily industrial; and shop experience—routing and scheduling. Prefers New York. C-483.

CONSTRUCTION MANAGER AND ESTIMATOR; M. ASCE; graduate civil engineer, licensed several states; 25 years' experience, handling building contracts of all types and similar structures; excellent estimator, purchasing, design, coordinator. Prefers Midwest or East. Available immediately. C-484.

CIVIL ENGINEER; Jun. ASCE; recent graduate, September 1948; 28; married; B.S. Carnegie Institute of Technology; wants construction work. Experience in Seabees and field engineering department of steel company. C-485.

STRUCTURAL OR PROJECT ENGINEER; Assoc. M. ASCE; 47; graduate civil engineer experienced in assuming full responsibility for the structural design and construction of industrial buildings and important heavy engineering structures; 25 years' experience in New York metropolitan area. Supervised design and construction; coordinator, client and job authority relations; cost minded. C-486.

Positions Available

ASSOCIATE ENGINEERS, 30–40, graduates, preferably registered professional engineers with from 8 to 15 years' experience, for a consulting engineer whose work covers surveys, reports, designs, construction and operation of water supplies, sewage systems, power plants, and highways, etc. Should be able to take responsible charge of work, both in the office and in the field. Will meet clients and carry on

(Continued on page 97)

Position Vacant

Professor and Chairman of Department of Civil Engineering, Eastern University.

Recognized specialist in Sanitary Engineering, with Teaching and Administrative Experience Preferred.

Address Box C. E. 180
CIVIL ENGINEERING
33 West 39th Street
New York 18, N. Y.

ENGINEER WANTED

Graduate Civil Engineer with broad experience, a substantial portion of which has been in hydraulics. An excellent opportunity with a large public utility located in eastern Pennsylvania. Apply by letter stating education, experience and salary requirements.

Box C.E. 181
Civil Engineering
33 W. 39th Street
New York City

BRIDGE DESIGNER WANTED

At least four years of experience in design of highway bridges. Must be familiar with design of intermediate structures, and capable of executing complete structural design of small bridges and elevated structures. Must be a graduate civil engineer. Location — Washington, D.C. Salary at approximately $5,200.00 per annum with periodic increases. Annual leave — 26 days a year. Pension plan.

Executive Office
Commissioners of the District of Columbia
Washington, D. C.

(Continued from page 96)

...Location, Pittsburgh, ...notations with ... Y-1761.

...ENGINEERS (a) Structural Engineers, graduates ...licensed, experienced primarily in the design ...grade-separation structures, and highway and ...way bridges. (b) Civil Engineers, young, ...graduates, capable of some designing, but principally of detailing both structural steel and ...inforced concrete structures incident to the ...construction of grade separations and railway ...highway bridges. (c) Structural Draftsman ...detail drafting only, with experience in this ... Write stating qualifications. Location, ...South. Y-1893.

JUNIOR ASSOCIATE PLANNER, 25–34, graduate, with an engineering or architectural degree or registered as a professional engineer or architect in the State of Maryland; with 4 years' experience in city planning, engineering or architectural work, 1 year of which must have been in responsible charge; graduate work related to urban or regional planning problems may be substituted. Will be responsible for technical studies and analysis. Some design work will be required, but major emphasis will be on the preparation and analysis of economic studies, estimates, and financing plans. Appointment will be temporary subject to civil service examination at a later date. Location, Maryland. Y-1980.

CONSTRUCTION SUPERINTENDENT with industrial building and equipment erection or general plant engineering experience, to take charge of manufacturing and process plant construction jobs. Considerable traveling. Salary, $6,500–$7,800 a year. Location, New York, N.Y. Y-2043.

ESTIMATOR, thoroughly experienced, for company doing a large volume of work on bridges, waterfront structures, and industrial plants. Salary open. Location, Virginia. Y-2184.

ASSISTANT ENGINEER, civil graduate, with training in surveying fundamentals and methods and 2 years' of practical experience in surveying. Experience in precise surveying and leveling desirable. Will act as chief of party. Must own car. Write stating experience and salary desired. Should be resident of New Jersey. Y-2222.

DESIGN ENGINEER, 30–50, civil graduate, capable of obtaining license as civil engineer, with experience in design, estimating, and preparation of specifications on general engineering work, particularly bridge or grade-separation work; previous railroad employment helpful. Location, Louisiana. Y-2243.

PARTY CHIEF, about 30, single, preferably civil graduate, with industrial construction experience, to lay out oil refinery buildings, structures, pipelines, and road, etc. Knowledge of Spanish desirable. Two-year contract. Salary, $5,400 a year, plus expenses and bonus. Location, Venezuela. Y-2269.

CHIEF DRAFTSMAN, 35–50, structural design background with broad supervisory design experience on tunnels, bridges, harbors and municipal work with Southern engineering firm. Salary commensurate with ability. Y-2272.

CIVIL ENGINEER, 35–40, graduate, with 12 to 15 years' experience on detail design and layout of hydraulic structures, the last 5 years of which should have been in responsible charge of reinforced concrete and structural steel design pertaining to such structures with emphasis on the concrete end, under general supervision only. Work covers dams, pump houses, powerhouses, steel and concrete penstocks, gates, racks, transmission-line towers, and switching structures. Should have knowledge of specification writing with regard to materials for structures outlined. Should have knowledge of the mechanical and electrical equipment peculiar to the above structures. Salary, $7,200–$9,000 a year. Some traveling to Brazil. Headquarters, Canada. Y-2275.

SANITARY ENGINEER, State Department of Health, degree in sanitary engineering, with at least 6 years' sanitary engineering experience, 2 of which were in responsible charge. Starting salary, $5,000 a year; retirement plan, civil service. Location, East. Y-2282.

SALES ENGINEER, 25–35, preferably civil graduate, with sales and field engineering experience, to sell surveying instruments to contractors, engineers, highway departments, and aviation companies, etc. Considerable traveling in South. Headquarters, East. Y-2295.

SALES ENGINEER with civil degree and at least 3 years' highway design and construction experience, to sell asphalt products to contractors and highway departments. Salary, plus cost-of-living bonus. Headquarters, New York, N.Y., with some traveling. Y-2296.

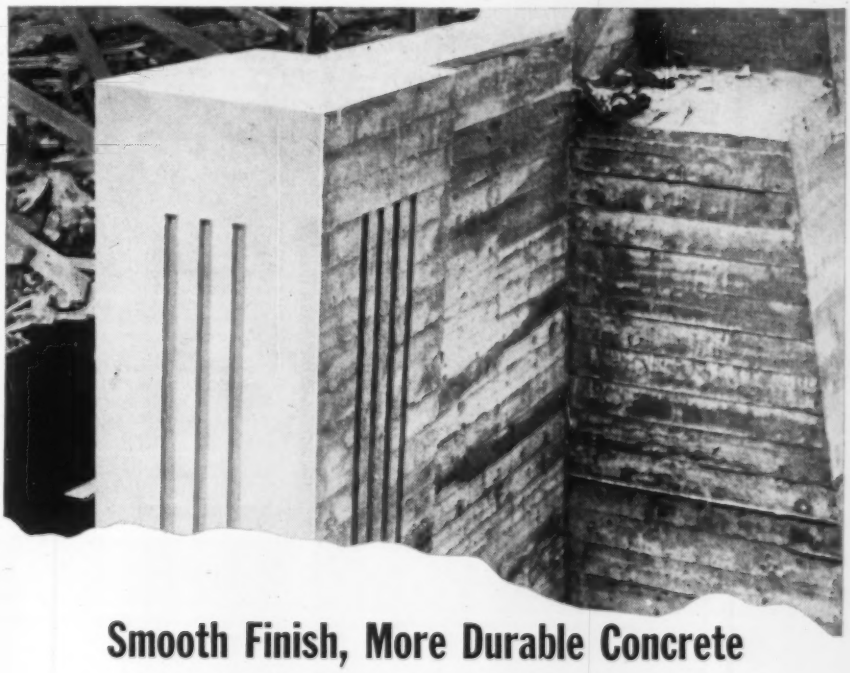
CIVIL ENGINEER, young, for editorial work consisting of preparing descriptions of new equipment and materials in the civil engineering construction field, as well as abstracting reports and papers for publication and writing convention reports. Some market-data and editorial research involved. Must know how to write and be familiar with the basic rules of journalism, as well as have a knowledge of engineering and construction. Will attend meetings, press luncheons and similar gatherings, to represent a publication and keep in touch with new developments in the field. Excellent opportunity. Location, New York, N.Y., Y-2316.

EXECUTIVE DIRECTOR responsible for directing the activities and administration, including planning, organizing and execution of a redevelopment program for a large city in southern California. Preferably college graduate, with major work in business or public administration, city planning, civil engineering, architecture or related subjects, and at least 8 years' recent experience, of which at least 4 years were in a responsible administrative capacity in promotional or organizational activities for civic or similar organizations or groups; or planning and development of large-scale subdivisions, neighborhoods or housing projects; or governmental planning. Salary, $11,280 a year. Y-2318-S.

DESIGNER, graduate civil engineer, heavy experience in water and sewage treatment, to carry out engineering and design work for a firm of architects and engineers. Salary open. Location, northern Indiana. R-5608.

DESIGNERS AND DETAILERS, experienced on reinforced concrete and steel bridges. Work for state highway department. Salary, $4,800 a year. Location, Missouri. R-5620.

DEPARTMENT SUPERVISOR (bridge engineer), 35–50, graduate civil engineer or electrical engineer, experienced with inland waterways, bridge department operations. Will run bureau controlling 60 or 70 tenders, office personnel and maintenance crew. Required to maintain, recommend improvements, make up budget, settle accidents, meet public, and handle personnel. Should have knowledge of federal laws regarding navigation, and state and city laws. Salary, $4,800–$5,400 a year. Location, Midwest. R-5627.



Smooth Finish, More Durable Concrete
with Hydron Form Linings

The near side of the concrete slab in the above photograph was cast against Hydron form lining. Note the smooth, unblemished surface obtained without expensive rubbing.

Hydron absorbs excess water and eliminates trapped air from the surface. This makes the concrete several times more resistant to abrasion and freeze-thaw conditions. The case hardening effect is gradual from the surface into the mass for about an inch in depth. In addition to these benefits Hydron serves as a curing aid. When the forms are removed Hydron remains on the concrete and can easily be taken off after the desired curing period.

Hydron is mounted on wood forms with rapid fire staple guns and on steel forms with a special adhesive. Furnished in flexible sheets, Hydron can be easily cut or trimmed.

Among the big installations where this product was used are: Fall River Dam, Norfork Dam, East Sidney Dam, Whitney Dam, Cherry Creek Dam, Soo Canal and lock walls, Chain Rock Canal, Delaware & Chesapeake Canal Bridge Abutments, Maine Turnpike Bridge Abutments.

NEW! Re-usable Rubber Bevel Strips Prove More Economical, More Efficient

The bevels or grooves in the above photograph were made by U. S. Rubber Bevel Strips. These strips produce a smooth finish with straight edges. And being flexible, they are easily removed for many more re-uses.

For more information write Hydron Department, United States Rubber Co., 1 Market Street, Passaic, New Jersey

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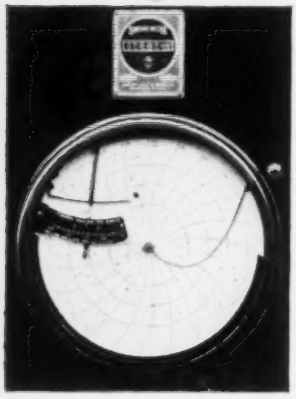
SERVING THROUGH SCIENCE

UNITED STATES RUBBER COMPANY

SIMPLEX

TYPE MS METER

Meets Highest Standards for Accuracy and Sensitivity!



Note these important features:

- Bell shaped float translates the half power of the differential into uniform graduations of dial and chart.
- Evenly spaced charts . . . easily read at high as well as low rates.
- Continuous type integrator — eliminates intermittent movement.
- High accuracy of flow readings over long ranges — 10 to 1 or 7.6 to 1.
- Wall panel or floor mounting — electric or spring wound clock optional.
- Rugged construction — simplified design that permits servicing by plant personnel.

Write for full information to

The Simplex Valve & Meter Company, Dept. 5, 6724 Upland Street, Philadelphia 42, Pa.

SIMPLEX

VALVE AND METER COMPANY

(*Continued from page 92*)

Reconstruction, Netherlands. The numerable problems involved in re structing the war-devastated areas of Netherlands have been summarized by Ministry of Reconstruction and Housing in a booklet entitled *Three Years of Re struction in the Netherlands*—and issued the Netherlands Government Informati Service. The booklet also shows in cise form what has been actually accom plished since the liberation of the Neth lands and gives a prospectus of future co struction.

Soil Mechanics. Results of a resear program on the performance of mod flexible anchored bulkheads backfilled wi different types of soils—initiated in 1943 the Navy Bureau of Yards and Docks Princeton University—have been report by Prof. Gregory P. Tschebotarioff, M ASCE, in a lithoprint. The project de veloped several new techniques, which per mitted the use of SR-4 strain gages over lo periods of time, and in an entirely submerg condition below water level. Inquir concerning the report should be addresse to Professor Tschebotarioff at Princet University.

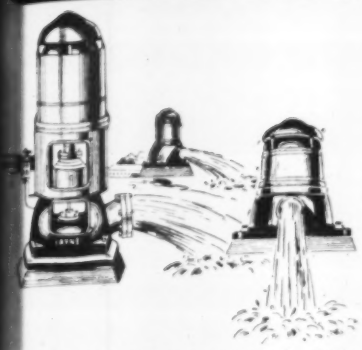
Structures. Recent structural investig tions undertaken by the Fritz Engineeri Laboratory of the Lehigh University Civ Engineering Department have been mad available in reprint form by the vario sponsoring organizations. The reprints in clude *Plastic Behavior of Wide Flange Bea* by W. William Luxion, Jun. ASCE, an Bruce G. Johnston, M. ASCE, which detail investigations made for the Structural Ste Committee of the Welding Research Coun cil; *Comparison of Notch Tests and Brit ness Criteria*, by C. J. Osborn, A. F. Scott brook, R. D. Stout, and B. G. Johnsto reporting a research program undertake for the Fabrication Division of the Pressu Vessel Research Committee of the Weldi Research Council; and *A Method fo Vibration Fatigue Tests of Stranded Co ductor*, by Al-ting Yu and Bruce G. John ston, which describes a development progra conducted for the Bethlehem Steel Co.

Environmental Sanitation. The in comprehensive listing of communities an their sanitary facilities has been prepared b the staff of the Public Health Service En vironmental Health Center at Cincinnati Ohio, in cooperation with the Sanitary Engineering Divisions of the states. Copi of the listing, entitled *Inventory of Wat and Sewage Facilities in the United State* may be obtained on request from the Office in Charge, Environmental Health Center Public Health Service, 1016 Broadway Cincinnati 2, Ohio.

Water Pollution. Studies on the treat ment of water, sewage, and industri effluents and on the effects of pollution natural waters, made by the Water Pollu tion Research Laboratory of the Britis Department of Scientific and Industri Research in 1947, are presented in a recen report of the Board. Copies may be pur chased by mail for 1s,8d, upon applicati to the Department of Scientific and Indus trial Research, Rex House, 4-12 Regen Street, London, S.W. 1, England.

BIG OR LITTLE

They All Have the Same Layne Quality

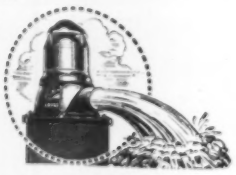


Layne has constantly maintained the highest quality of materials and finest precision manufacturing in all of their Well Water System installations. The smallest are just as substantial in construction and as high in efficiency of operation and always produce proportionately as much water as the biggest. This fact has been proven time and again to the complete satisfaction of hundreds of owners.

When Layne builds a Well Water System, more than fine casing, impellers, shafting, motors and skillful manufacturing are used. Layne's reputation extending back over nearly three quarters of a century as the world's most capable well water developers is included.

All Layne Well Water Systems are equipped with the famous high efficiency Layne Vertical Turbine Pumps. These pumps are designed and manufactured exclusively in Layne's own plant where every detail of their construction and assembling is under the supervision of engineers.

Write for catalogs and information about Layne's complete service which includes surveys, water strata explorations, pump installations, etc., for a complete Well Water System. Address LAYNE & BOWLER INC., General Offices, Memphis 8, Tenn.



LAYNE WELL WATER SYSTEMS

AFFILIATED COMPANIES: Layne-Arkansas Co., Stuttgart, Ark. • Layne-Atlantic Co., Norfolk, Va. • Layne-Central Co., Memphis, Tenn. • Layne-Northern Co., Mishawaka, Ind. • Layne-Louisiana Co., Lake Charles, La. • Louisiana Well Co., Monroe, La. • Layne-New York Co., New York City. • Layne-Northwest Co., Milwaukee, Wis. • Layne-Ohio Co., Columbus, Ohio • Layne-Pacific, Inc., Seattle, Wash. • Layne-Texas Co., Houston, Texas • Layne-Western Co., Kansas City, Mo. • Layne-Minnesota Co., Minneapolis, Minn. • International Water Corporation, Pittsburgh, Pa. • Layne-Hispanoamericana, S. A., Mexico, D. F.

Recent BOOKS

DESIGN OF STEEL BUILDINGS. 3 ed. By H. D. Hauf and H. A. Pfisterer. John Wiley & Sons, New York; Chapman & Hall, Ltd., London, 1949. 280 pp., illus., diagrs., charts, tables, 8¼×5½ in., cloth, $5. This book presents the general principles of structural design as applied to the framing of commercial, institutional, and residential type buildings. In this edition the material on welded construction has been expanded. In addition to a general discussion of welded framing connections, the application of welding to the design of plate girders and roof trusses is treated in detail. The chapter on the design of beams has been rewritten, and a more detailed treatment of the use of safe loading tables included. All the problems have been revised and new ones added.

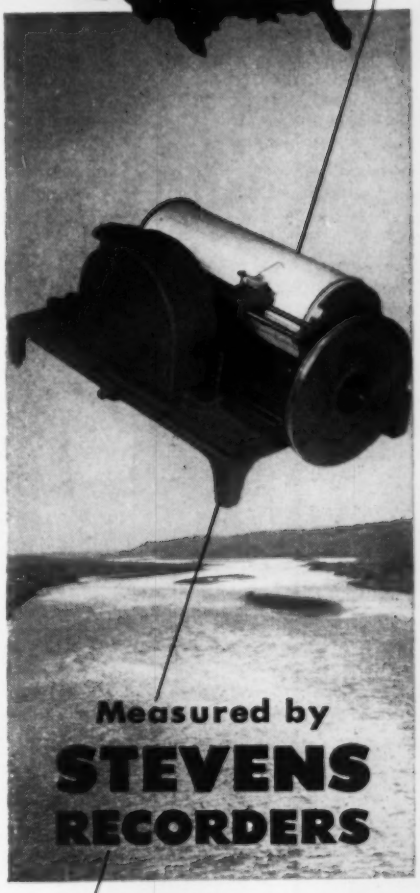
FLUID MECHANICS. 2 ed. By R. C. Binder. Prentice-Hall, New York, 1949. 361 pp., illus., diagrs., charts, tables, 9¼×6 in., cloth, $5.65. The aim of this book is to present an introduction to the fundamentals of fluid mechanics, keeping physical concepts and established quantitative relations in the foreground. Statics, kinematics, and dynamics are considered, followed by discussions of viscosity, dimensional analysis, and dynamic similarity. Instruments, hydraulic machinery, and particular cases of flow are then treated. Each chapter is followed by a list of selected references and numerous problems.

PRINCIPLES OF MECHANICS. 2 ed. By J. L. Synge and B. A. Griffith. McGraw-Hill Book Co., New York, Toronto, London, 1949. 530 pp., diagrs., charts, tables, 9¼×6 in., cloth, $5. This volume is a text for intermediate courses in mathematics, physics, and engineering mechanics departments. The principal revision of this second edition occurs in the rewriting of the account of the motion of a charged particle in an electromagnetic field. Other changes include: Amplification of the treatment of principal axes of inertia, and revisions in the material on Foucault's pendulum, the spinning projectile, and the gyrocompass. The emphasis on units and dimensions has been increased. A few additional exercises have been inserted, and numerous minor corrections made.

STATISTICAL YEAR-BOOK OF THE WORLD POWER CONFERENCE, No. 4. Data on Resources and Annual Statistics for 1936–1946, edited by F. Brown. World Power Conference, 201–2 Grand Buildings, Trafalgar Square, London, W.C.2, 1948. 212 pp., tables, 11×8½ in., cloth, £2·5s. This compilation contains statistics of the resources, production, stocks, imports, exports, and consumption of power and power sources in all the countries of the world for which it was possible to obtain information. The power sources included are coals, brown coal and lignite, peat, coke, manufactured fuel, wood, petroleum, benzoles, alcohols, natural gas, manufactured gas, water power, and electricity. Most of the statistics were supplied by government organizations in the countries concerned, and conform to standard definitions which are reproduced in the text.

TEXTBOOK OF WOOD TECHNOLOGY, Volume I. By H. P. Brown, A. J. Panshin, and C. C. Forsaith. McGraw-Hill Book Co., New York, Toronto, London, 1949. 652 pp., illus., diagrs., tables, 9¼×6 in., cloth, $6. This book is based on "Identification of the Commercial Timbers of the United States" by Professors Brown and Panshin. It offers factual information on the structure, identification, general properties, uses and major defects of commercial wood in the United States. The International Code of Nomenclature is used. A new master key for the identification of coniferous woods has been added, and the glossary of technical terms enlarged. The projected second volume will cover the physical, mechanical and chemical properties of wood.

WATER America's lifeblood



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GRAPHIC RECORDS are the prime requisite in the control and utilization of water. Stevens Type F Water Level Recorders are providing these graphic records daily in irrigation, water supply, hydraulic experiments and sewage waste studies.

The Type F Water Level Recorder has been developed to provide automatic records of liquid levels at a minimum of cost.

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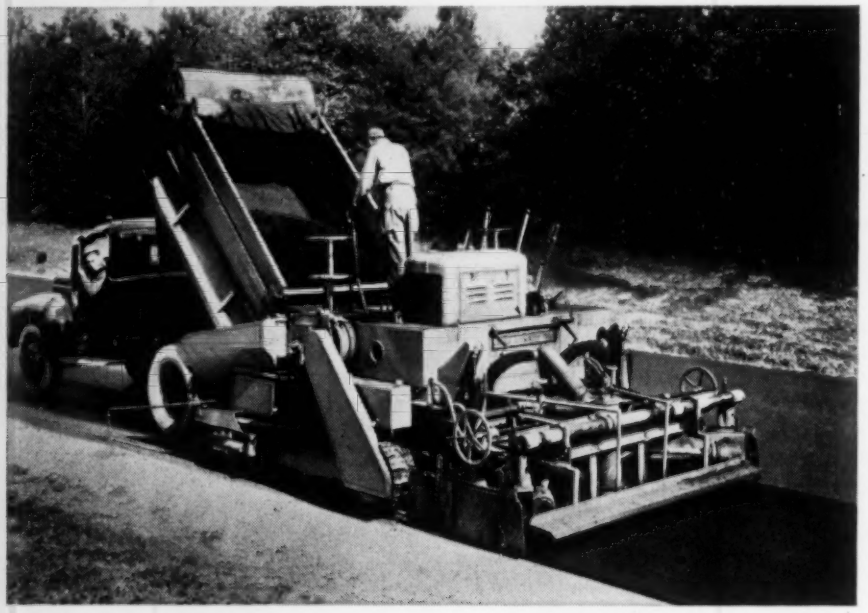
EQUIPMENT, MATERIALS *and Methods*

NEW DEVELOPMENTS OF INTEREST, AS REPORTED BY MANUFACTURERS

Bituminous Paver

A BITUMINOUS PAVING MACHINE, Model BP-5, is capable of laying the most difficult types of material, hot or cold, of dense or open texture, and with more uniform density and longer-wearing smoother-riding qualities. The machine lays any width of paving between 5 ft 8 in. and 12 ft 6 in. and can lay 25 foot pavement in two lanes without special attachments. The paver is almost instantly adjustable for any width between 9 ft and 12 ft 6 in. by merely turning a handwheel and without stopping the machine. Hydraulic device automatically and positively matches level of course being laid with adjacent course, curb, gutter or other grade line, maintaining exactly correct thickness for final compaction by roller. The machine is also able to pave flush to curbs and insures perfectly blended and sealed joints between adjacent lanes. Lays any mat thickness up to 6 in., with precision-smooth surface guaranteed by its long straightedge equalizing runners and automatic, hydraulic leveling pans which hold the rear screeds to level established by the center screed. Weight of the machine and effect of its traction are never on the material being laid, thus there is no premature sealing of material that requires aeration. The 6-ton hopper insures ample material for continuous operation, as fast as trucks can deliver. The machine offers users eight working speeds, ranging from 5 to 50 rpm. Road speeds range from .6 to 2.0 mph. Power is from a 6-cylinder, radiator-cooled gasoline engine of 37.5 hp at 1600 rpm, with throttle and governor control. **Jaeger Machine Co., Columbus 16, Ohio.**



The BP-5 at Work

Concrete Finish

A SPEED FINISH for exterior and interior new or old concrete walls has been developed. Permanent, uniform and protective, this finish gives a remarkably smooth coat. It is easy to apply with a cork float. The exterior type, consisting of a bonding coat and a finishing coat gives a smooth, waterproof surface. The regular interior finish, which requires but one application, is so smooth that paint may be applied directly to it, eliminating the necessity of plastering the wall. The interior finish is a special powder that is merely mixed with water before application; the exterior bonding and finish coats are mixed with sand as well as water. The resulting compounds make a chemical as well as a mechanical bond with the concrete. Exterior speed finish is applied in two coats. The first fills voids and smooths the wall. Since the second, or finish coat, may be applied after the roof is on, there is no more concrete to be poured and a uniform color can be obtained over the entire structure. The special finish for interior walls can be left natural or painted. No bond coat is needed; there is a plaster-smooth surface which is amply covered by one coat of cold water paint. **Irvington Form & Tank Corp., Irvington, N.Y.**

Slide Rule

EASE OF OPERATION, compactness, and low price are features of a tiny pocket slide rule ($6\frac{1}{2}$ in.) made of Vinylite plastic. The slide rule is a time-saving instrument for solving problems involving multiplication, division, proportion, squares, square root, cubes, and cube root. This item was developed principally for use by students desiring to learn how to operate a slide rule, and for other uses where extreme accuracy is not essential. It is made of ivory-color material, printed in black and red. **Plastilite Products Co., 32 Central Ave., Pawtucket, R.I.**

Truck-Mounted Crane

A $\frac{1}{2}$ YD, 10-TON truck-mounted crane and excavator has been announced. Known as the Model 44 Corsair, the machine travels at truck speeds, swings at $5\frac{1}{2}$ rpm and is convertible to all crane and shovel attachments. The six-wheel, tandem-type carrier, built especially for crane mounting, is of 16 in.—45 lb, steel "I" beam construction. Outrigger tubes are integral with frame—one pair ahead of front wheels and one pair behind rear wheels—to provide maximum rigidity and stability. Improved boom clearance and visibility are achieved by an offset, one-man cab and tapered frame ends. Crane features include four 20-in. clutches, enclosed gears running in oil and a worm-driven boom hoist. Oversized shafts mounted on rigid antifriction bearings are said to reduce wear and upkeep costs. The upper works is held in position by conical hook rollers and revolves on a 48-in. diameter ball bearing. Safety features include a full-vision cab, boom snubbers and a spring-loaded boom check brake. The crane is powered by an eight-cylinder gasoline engine which develops 62 hp at 1800 rpm. For complete job data and other information, write **Wayne Crane Div., American Steel Dredge Co., Inc., Fort Wayne 1, Ind.**

Model 44 Corsair

Truck Crane

PRODUCTION OF P&H Model 255-A truck crane has recently been announced. The crane has a 135 ft boom and 20 ft jib. Outriggers are not necessary because of the machine's extreme stability, even in making 360° swings with 2-ton loads, operating at about 15° radius. The design of truck

Model 255-A

cranes provide greater safety with independent planetary, triple safe boom hoist. This mechanism is entirely independent of all other operations and prevents the boom from dropping while raising or lowering. Additional stability is provided by the torsional bar front axle construction. This feature provides greater flexibility in handling loads more safely, under all conditions. It snubs front end tipping action and equalizes the load on the spring while craning. **Harnischfeger Corp., Milwaukee 14, Wis.**

Compressor-Dump Truck

A NEW "AUTO-AIR" compressor-dump truck combination unit has been developed. The assembly consists of either a Model 105 or 160 cfm auto-air compressor mounted ahead of a standard dump body on the truck chassis. The compressor is driven direct from the truck engine through the Davey heavy duty power take-off. The dump body can be employed to haul rock, broken pavement, or other materials dug or dislodged by the compressor. Also, the unit functions as a regular dump truck when the compressor is not in use. The assembly has many applications in utility, highway department and city maintenance fields. It is also ideal for use by contractors and on strip mine, railroad, waterworks and pipe line projects. **Davey Compressor Co., Kent, Ohio.**

. . . cut design, construction and maintenance costs with a

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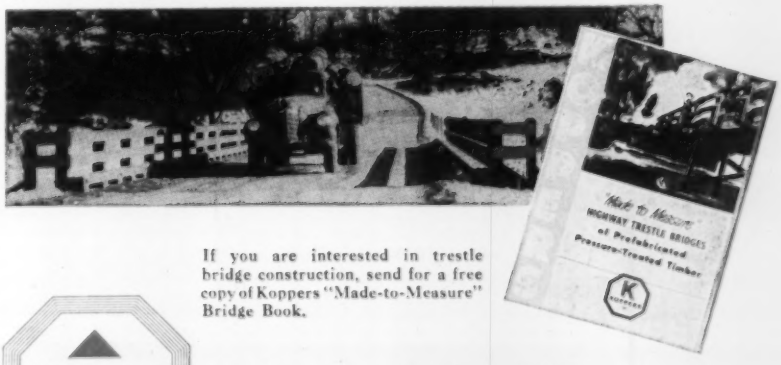
*"Made-to-Measure" Bridge**

● Your savings *start* in the drafting room! Various types of abutment, bent, deck and railing bridges are detailed, dimensioned and blueprinted in Koppers "Made-to-Measure" Bridge Book. Select the types desired; then, on a data sheet, provide certain essential information as to dimensions and site; send to Koppers for a quotation. Your project can reach the quotation stage in a fraction of the time, and with substantial reduction of the preconstruction expense usually required.

Your savings *continue* through construction! By standardizing parts and dimensions, bridge members can be framed, treated and shipped to the job site all ready to be assembled. Erection can be made by highway crews plus local labor. No special equipment is needed.

Your savings *continue* through the years! Bridge members are made of standard grades of wood—wood that has been properly seasoned, then pressure-treated. This pressure-treatment protects the wood against decay . . . assures maximum life with minimum maintenance.

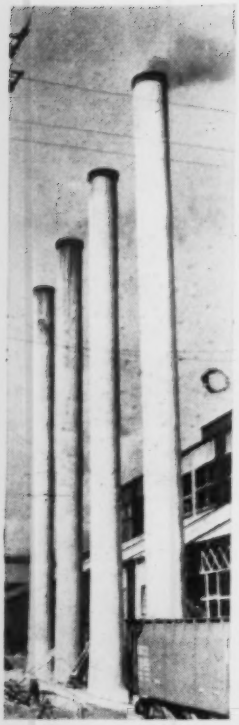
**With the use of rolled I beams and pressure-creosoted construction, it is possible to have clear spans up to 76'.*



If you are interested in trestle bridge construction, send for a free copy of Koppers "Made-to-Measure" Bridge Book.

KOPPERS PRESSURE-TREATED WOOD

KOPPERS COMPANY, INC., Pittsburgh 19, Pa.



Monolithic Stacks Built with "GUNITE"

SINCE 1924, we have built more than 200 self-supporting "GUNITE" stacks for steel mills and other industrial plants.

In building the four stacks shown at the left, the old deteriorated steel stacks were used as forms. They were not taken out of service during construction. Plywood forms are used for new construction and for extending the height of existing stacks.

The cost of building or rebuilding stacks with "GUNITE" is surprisingly low. The seamless, non-porous, monolithic nature of "GUNITE" stacks gives them a life expectancy considerably greater than stacks of steel or reinforced concrete. Many "GUNITE" stacks, in service for more than 20 years, are still in good shape, without maintenance of any kind.

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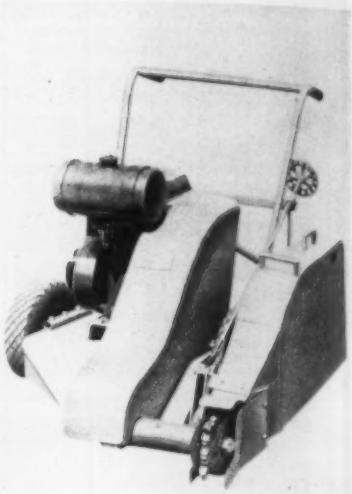
Equipment, Materials & Methods (Continued)

Expansion Joint Remover

A FAST, SURE METHOD of removing old asphalt expansion joints on streets, highways and airports has been developed. The machine was developed at the request of highway maintenance engineers, to fill a critical need: that of a unit capable of uniformly removing asphalt joints, equipped with an adequate pick-up for waste material. An exchangeable cutter

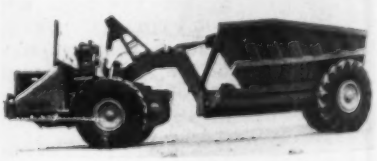


Joint Remover Unit

accommodates various width of joints and the counter-clockwise motion of the cutter head tends to pull the machine forward thus helping the operator. **San Jose Pipe & Tank Co., 1596 W. San Carlos St., San Jose, Calif.**

Terra Cobra Wagon

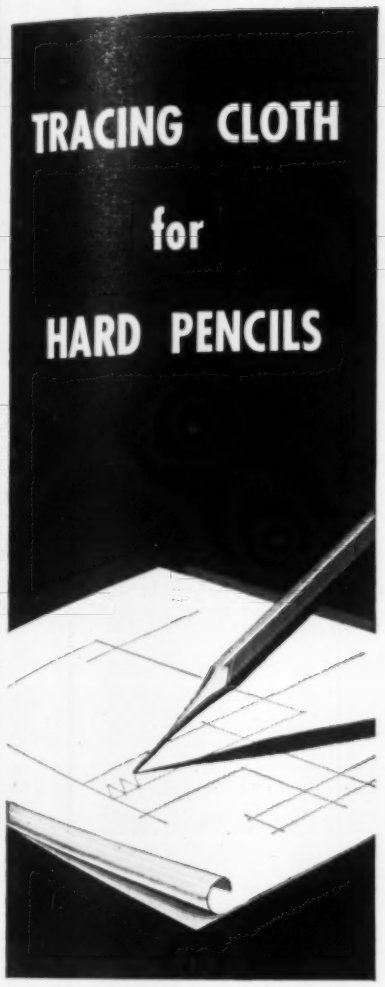
PRODUCTION OF the new Terra Cobra Wagon Model TC-W14 has just been announced. It is available complete with 200 hp Terra Cobra Model TC tractor, or as wagon unit Model W14 only, designed



Model TC-W14

for quick interchange with scraper unit on all models of Terra Cobra self-propelled scrapers. With a heaped capacity of 20 cu yd, and 14.0 struck, the tapered bottomless hopper spot dumps to rear, or spreads to desired lift by moving back on

(*Continued on page 103*)



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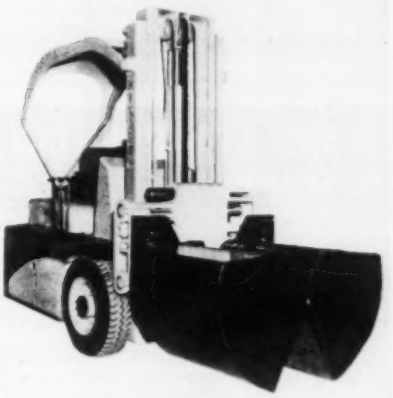
Equipment, Materials & Methods (Continued)

roller tracks. Positive fore and aft motion of body is effected by air controlled cables reeved without reverse bends in such a manner as never to contact load. Cable is accessible at all times. Hopper, which will pass rock up to 48 in. diameter, and stationary chassis bottom plate are of heavy abrasion resistant alloy steel. The hopper is ruggedly braced on all sides. Designed balance maintains complete stability even with hopper in extreme position, permitting dumping over bank, or into pockets of back-up, run-around, or run-over type. **Wooldridge Mfg. Co., Sunnyvale, Calif.**

Clamshell Bucket

A CLAMSHELL BUCKET of $^{7}/_{16}$ cu yd capacity for a lift truck is being announced by Hyster as another variation of the already versatile load-grab attachment for specialized materials handling. The clamshell is available only for the Hyster "40" lift truck. The unit mounts on the sliding supports of the basic load-grab as optional equipment. Operated by a lever at the driver's right, the clamshell opens and closes by means of the same hydraulic power which spreads and contracts the arms of the standard load-grab. Such bulk materials as sand, grain, chemicals, fertilizer, insulating materials, etc., are effectively handled by the tool. A standard lifting height of $8\,^{1}/_{4}$ ft (to the bottom of the closed bucket) makes it a valuable aid in such operations as loading and unloading trucks and railroad cars. **Hyster Co., Portland 8, Ore.**



Materials Handling Unit

Speed Transmission

SEAMAN PULVI-MIXERS are now being equipped with a selective speed transmission which provides a variation in rotor speeds best adapted to the job requirements. Variable rotor speeds increase the efficiency of the mixer and also improve the quality of the work accomp-

(Continued on page 104)

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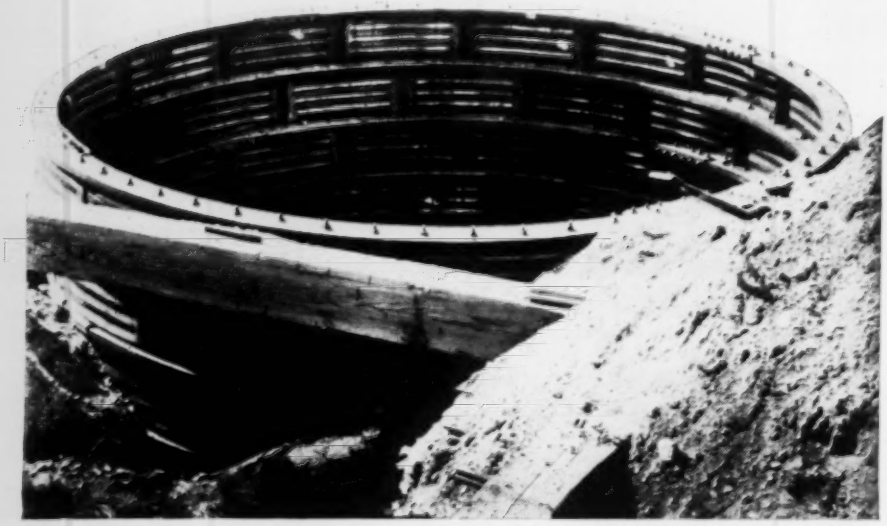

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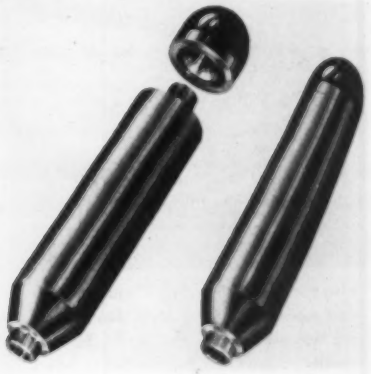
Equipment, Materials & Methods (Continued)

lished. The addition permits pulverization to a much greater depth; the mixing of aggregate of much larger diameter; better pulverization of stiffer clays and more thorough blending of stonier soils. In addition, there is a pronounced saving in time breakage and normal wear and tear on the entire unit as well as fuel savings on many jobs. It is now standard on all motorized models and extends the use of the mixer to many types of construction activities that were heretofore impractical—such as deep treatment of sub-bases, doctoring of frost-Boils, and the large scale construction of macadam roads and airport bases. **Seaman Motors, Inc., 305 N. 25th St., Milwaukee 3, Wis.**

Rubber-Tipped Vibrators

A CONSTANT PROGRAM of research and development is carried on, in the laboratory and in the field, to determine more economical and practical methods of concrete placement. Damage to expensive form has long been a constant source of annoyance and expense to the contractor.



New Vibrators

Realizing that a solution to this problem would save thousands of dollars in form placement cost, Viber has developed the idea of using rubber-tipped vibrators. Rubber-tipped vibrators proved to be a practical method of reducing form costs. Plaster of paris inserts for architectural concrete, plywood or any of the popular moisture-absorbent form lining materials such as Celotex can now be vibrated with a minimum amount of damage. Further information may be obtained by writing **Viber Co., 726 S. Flower St., Burbank, Calif.**

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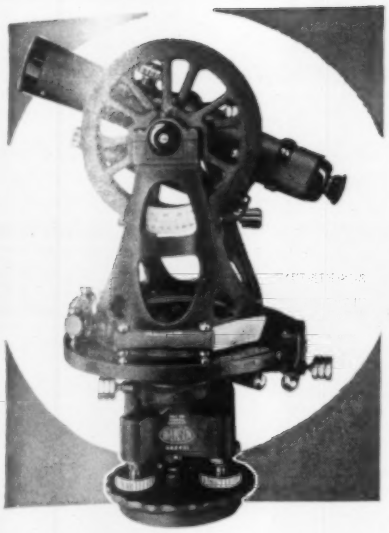
(Continued on page 105)



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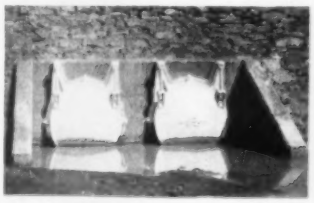

Fig. B-124-D

Two 60" Type M Gates on Relief Culverts near Woodward Pumping Station, Plymouth, Pa.

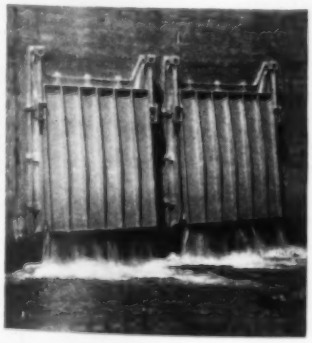

Fig. B-124-C

Two 72" x 72" Type M-M Gates on Toby Creek Outlet Works, Plymouth, Pa.

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Equipment, Materials & Methods (Continued)

strip of concrete. With the sprayer, one man can treat as much concrete in 20 min as can be done in a half-day by one man using old-fashioned methods. An extra

Spray Unit

side nozzle is provided for spraying edges of concrete surfaces, generally difficult areas to cover thoroughly. The uniform spraying action of the sprayer makes it easy for the contractor to comply with concrete curing specifications simply by allotting a tankful of curing compound to a definite area. **Devere Co., Racine, Wis.**

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Literature Available

CHARACTERISTICS OF METALS—A 63-page booklet entitled "Fundamental Characteristics of Revere Metals" gives in non-technical language the basic technology of copper, brass and bronze. Among the topics covered in detail are copper and its alloys; cold working and hardness; annealing, corrosion, and specifications. Included is a 7-page glossary of metallurgical terms. **Revere Copper & Brass Inc., 230 Park Ave., New York, N. Y.**

DRAGLINE OPERATIONS—Revised edition of "How to Get The Most Out of a Page Automatic Dragline Bucket" is now available. This 20-page booklet has detailed information on dragline operations, which makes it a veritable handbook for operators. How to select the right size bucket, how the bucket operates, how to use it and care for it to get maximum production, are a few of the subjects discussed and illustrated. **Page Engineering Co., Clearing Post Office, Chicago 38, Ill.**

MOLDING METHOD—A 4-page folder describing "Ductube," a newly developed pneumatic rubber tubing for molding ducts or holes in concrete or other mastics, has been released. The bulletin suggests that these ducts may be used for power, light, and telephone lines. . . .also for drains, grout holes, air radiant heating and etc. Diagrams illustrate the four simple operations for molding ducts. **Ductube Co., 940 Shoreham Bldg., Washington, D.C.**

WASTE TREATMENT—Bulletin No. 70 entitled "Waste Treatment to Comply with Stream Pollution Control Regulations" has just been released. It is intended primarily to inform the industrial plant executive or municipal engineer, who is charged with responsibility for pollution control, of the latest important methods of waste treatment. The bulletin describes briefly the general problems involved and then discusses the principal treatment methods. Actual case studies are reported. **Infilco Inc., 325 W. 25th Place, Chicago 16, Ill.**

PHOTOGRAPHIC INSTRUMENT DISPLAYS—A number of attractive 2-color reproductions of engineer's transit are available. The large (18 × 24 in.) cardboard mounted photographs are laminated and were prepared especially for classrooms, company libraries, business libraries, business offices, etc., and are ready to hang. The posters are particularly suitable for visual education, training, and display purposes. **The David White Co., 315 W. Court St., Milwaukee, Wis.**

DIESEL ENGINES—The many fields to which users have applied diesel power are highlighted in a 16-page illustrated booklet designated as Form 12109. The publication points up installations in hotels, ski-lifts, sawmills, gins, drill rigs, rock crushers, mining, water pumps, dredges, refrigerating plants, pipelines, air compressors, shovels, locomotives, hay balers, feed mills and irrigation pumps. **Caterpillar Tractor Co., Peoria 8, Ill.**

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Literature Available (Continued)

DOWEL INSTALLER—Bulletin K-10 covers the operation of the Flex-Plane mechanical dowel installer. The machine vibrates dowels and tie bars into the concrete slab and rides on forms behind the finisher. Employing on-the-job photographs, the new bulletin shows in detail the operation of the machine. **Flex-Plane Co., Warren, Ohio.**

PUMP LIFE IMPROVED—How the selection of materials for the construction of pump and pump parts can add to the life of such units is told in a new booklet entitled "How to Get Longer Service From Your Pumps." It contains eight illustrated pages showing how corrosion, corrosion-fatigue erosion and wear affect pump life. **The International Nickel Co., Inc., 67 Wall St., New York 5, N.Y.**

SWIMMING POOL EQUIPMENT—Bulletin No. 2157 describes the latest equipment for recirculation, filtration, chlorination, softening and pH control. Manual and automatic valves are explained and many installations are illustrated. A complete line of accessories, such as suction cleaners, heaters and test kits, are described. Complete specifications are given. **Permutit Co., New York 18, N.Y.**

PORTABLE CONVEYOR—An 8-page bulletin, just released, contains information on the all-purpose Model 363 portable belt conveyor. The versatility, adaptability and capacities of the 363's, which are made in lengths of 25, 30 and 35 ft with plain or cleated belts, are outlined in the booklet. Two pages of applications are helpful in suggesting possible uses that the 363 may be adapted to. Drawings show how the conveyor may be adapted to many conditions. **Barber-Greene Co., Aurora, Ill.**

HYSPEED WINCH—Specifications and features of the new Hyster hyspeed winch for use with Caterpillar D8, D7, D6, and DW10 tractors are described in form no. 1121. The winch is light weight, high speed, friction driven, single drum and free spooling. It is primarily designed for high speed logging over rough ground where a large size tractor is needed, yet the wood is small. The unit can also be used for a number of industrial applications, the design being such that it will fit nicely into stiff-leg crane boom designs. **Hyster Co., Portland 8, Ore.**

INSULATED PIPING BOOKLETS—Two new booklets of particular interest and practical usefulness to engineers, who deal with problems involved in insulated piping distribution systems have been recently published. "Engineering Data for Underground Steam Distribution, Section 480-2" deals with the layout of the route, methods of estimating steam loads, steam flow charts and tables. "Typical Engineering Drawings, Section 480-3" reproduces actual drawings used in a wide variety of insulated piping installations. **The Ric-Wil Co., Dept. A23, Union Commerce Bldg., Cleveland, Ohio.**

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